Table of Contents

Section One - Detecting the Presence of Hazardous Materials

Chapter One - Introduction

How often do you see a rail car or a tank truck pass by you? Chances are, it is more than you think. On an average drive from Lexington to Morehead or from Elizabethtown to Bowling Green you probably pass over 150 vehicles carrying a significant amount of hazardous materials, not to mention the businesses that store, use or manufacture hazardous materials. Most times, hazardous materials flow through the Commonwealth without incident. However, the Kentucky Division of Emergency Management logged 2,155 different occasions from October 1, 1999 until September 30, 2000, when one or more hazardous materials endangered the health of humans, the environment, or property.

If you are in this course, **you are a member of a team that responds to a hazardous material release.** You are expected to protect people, environment, or property from the effects of the release of a hazardous material. You will be expected to contain the release from a safe distance, in order to keep the material from spreading. **Are you prepared to do this?** Can you safely, effectively and efficiently stop the flow of green goo as it approaches the town? Chances are, if you are in this class, you are searching for the skills and knowledge to do this.

This course is specifically designed for the emergency responders in the Commonwealth of Kentucky. Whether you are a member of an emergency management team in Marshall County, a firefighter in Jefferson County, or a water superintendent in Pike County, this course applies to you. For the first time ever, local law enforcement professionals will be receiving this course as part of their incentive program training. In addition, the Kentucky Emergency Response Commission is taking steps to reach responders in the most distant, most rural areas of the state.

Course Pre-requisites and Expectations

This course is a 12-hour discovery of the defensive actions of a hazardous materials first responder. **You are required to have successfully completed the Hazardous Materials First Responder Awareness level training and maintained your proficiencies in accordance with 29 CFR 1910.120.**

You will notice that there is not a review of the awareness level material. This course builds on the information from the awareness level course. You are expected to know that material before you take this course. However, there are essential learning points built into this course from the awareness level.

Course Format

Think for a moment how you respond to a hazardous materials incident? What are the steps you follow to effect a safe, efficient and effective response? If you are a member of a hazardous materials response team, whether it is part of the local fire or EMS department, a task force assigned to breaking up meth-labs or a regional or state team formed specifically for hazardous materials response, you have specific departmental procedures that outline how you should respond to an incident. What do those general operating guidelines direct you to do?

Chances are these guidelines will direct you to first detect the presence of a hazardous material. Next, they will direct you and your team to determine whether or not there is a need to act. If you

are able to determine the need to act, then you and your team will need to determine what you can accomplish and you will plan how to accomplish it. Then you follow that plan and evaluate the progress to determine if the plan is working.

There is logic to a hazardous materials response. You cannot realize an effective or efficient hazardous materials response without doing it safely. Nor are you able to safely execute a hazardous materials response without being effective or efficient. Likewise, you will not be able to determine your response plan without knowing what kind of materials you are dealing with.

This is why Ludwig Benner, Jr., a member of the United States National Transportation Safety Board developed D.E.C.I.D.E. in 1975. For the same reason, the Kentucky Emergency Response Commission has chosen this to provide the framework for the hazardous materials first responder operations level.

Furthermore, the Kentucky Emergency Response Commission believes in the philosophy of train as you work, therefore, this course is designed using the D.E.C.I.D.E. model.

D - Detect the presence of hazardous material

E - Estimating likely harm without intervention

C - Choosing response objectives

I - Identifying action options

D - Doing the best Option

E - Evaluating progress

If you are a veteran hazardous materials first responder, you may recognize this model. The D.E.C.I.D.E. model was first proposed by Ludwig Benner, Jr. in an article in the July 1975 Fire Journal. This model has withstood the test of time and remains current 26 years after its introduction.

Course Expectations

There are certain expectations that the Kentucky Emergency Response Commission (KyERC) has for your successful completion of this course. First, you must be willing to participate in the classroom activities. Second, you must score a seventy (70%) on the written examination. The examination is based largely on the enabling objectives that are listed at the beginning of every chapter. Finally, safety is understood and is an integral part of this training. Safety, efficiency and effectiveness are the foundations for this course and hazardous materials response.

On behalf of the Kentucky Emergency Response Commission, the Kentucky Division of Emergency Management, the Kentucky State Fire Marshal's Office/Hazardous Materials Division, the Kentucky State Police and a whole host of other local and state emergency response agencies, thank you for taking the time to attend this class and be safe in your training and in your responses.

Introduction To Hazardous Materials First Response Operations

The Kentucky Division of Emergency Management has developed this course for the Kentucky Emergency Response Commission. **This course is designed for individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, the environment, and property from the effects of the release**.

If this describes your duties, then this course is for you.

This course will train you to **respond in a defensive fashion** without actually trying to stop the release. Your primary function in this level of response is to try to **contain and confine the release from a safe distance, keep it from spreading, and preventing exposures**.

As a first responder, you put your life in danger on a regular basis. Whether it is running into burning buildings to search for missing victims or subduing a felon or managing a large scale disaster, you assume a certain amount of risk to help others. However, as you learned in the hazardous materials first responder awareness level course, the hazardous material incident is different from other incidents because hazardous materials are so plentiful and they have wide-ranging characteristics. In addition, past training has presented many challenges to responder safety at hazardous materials incidents. It is the goal of the KyERC to reduce the danger to you by increasing your awareness and proficiencies in hazardous materials firs response.

General Scene survey (Weather/External Factors)

As a hazardous materials first responder at the awareness level, you were taught how to recognize and identify the presence of a hazardous material. However, your training did not go beyond this because you were in a position where you might witness or discover a release of a hazardous material.

Now, you are preparing to be a hazardous materials first responder at the operations level. This means that you are now **responding** to a release or potential release of a hazardous material(s). Therefore, it is important that basic response and scene guidelines are covered. The goal of this section is simple: to expand your abilities at surveying a hazardous materials incident scene.

Scene Assessment Guidelines

As a responder in Kentucky, scene assessment begins at the time that an incident is reported. You must rely on the abilities of the dispatcher to use his or her training to obtain the most complete information from the often hysterical, sometimes evasive callers.

You then have to use clues and signs that bring you closer to the possibility of being exposed to the hazardous material. Your goal of scene assessment must rest on providing for your safety. This means you must stay alert to all hazards. For example, during the Danville Boxcar fire in April of 2000, a fire truck was damaged and a state employee was injured, not by exposure to the hazardous materials, but due to inattentive driving on unknown terrain.

Unfamiliar surroundings led to this wreck. Picture courtesy of the Natural Resources and Environmental Protection Cabinet.

As an emergency responder, you probably know that all incidents have common points of reference. In this section, you will learn about initial scene approach and assessment, establishing

command and control activities, establishing site control, and how to map a site. Throughout this course, your instructor will build on this foundation. These are general guidelines and not intended to override your local emergency operations plan or your department's general operating guidelines.

The assessment of the incident is an ongoing process, until the incident is properly terminated. This is true for motor vehicle collisions, EMS runs, as well as hazardous materials incidents. You should always approach a scene from uphill, upwind and upstream. If this is not practical, then you should approach at a right angle to the wind direction and / or gradient. This is important, especially if you are among the first arriving units to a known or potential hazardous materials incident. If you do not follow this, you may find yourself, your team and that $ 90,000 ambulance that your boss is so fond of in the middle of a release of a hazardous material. If this happens, and you live, be certain to count your blessings.

1. **Consider all hazards**. As you approach the scene, take in to considerations all of the hazards. Many responders have been injured not by the hazardous material on the ground or the shooter in the house, rather they have been injured by some other hazard, such as the high voltage line, the swift river, or some other hazard that was over looked during the initial size up.
2. **Establish the Incident Management System.** – Keeping the "big picture" in view is why establishing the incident management system as rapidly as possible. The incident management system (IMS) provides guidance at the scene of an incident. It allows qualified leaders to interface with other specially qualified personnel to make a plan that can be executed safely, effectively and efficiently.
3. **Assign a Safety Officer** - Assigning a safety officer is important to your safety and the safety of your team and the public. The safety officer's number one task is to keep him or her, you and your team, and the public safe. 29CFR 1910.120 (q) mandates that a safety officer be assigned. It is not only good practice…**IT IS THE LAW**.
4. **Establish Control Zones** - At the awareness level you were taught to establish an isolation zone and deny entry to others who are not in proper personal protective clothing or do not have a specific assignment. As the hazardous materials first responder at the operations level, you cannot avoid this responsibility. In fact, at the operations level, you will establish cold, warm and hot zones.
5. **Identify the hazardous material (if possible)** - At the awareness level, you were taught simply to recognize the presence of a hazardous material. At the operations level, you will learn to identify the hazardous material. This is very important because you must determine the material before you can determine the proper personal protective equipment (PPE).
6. **Perform risk analysis** – You have perform a risk analysis to determine whether or not you should act (including rescue) or let the event stabilize without intervention.
7. **Notify Appropriate Authorities** – In addition to your response, you may need to call on others with advanced or specialized skills to aid you in your response. In addition, you may more money to pull off the response or get federal compensation. Therefore, you must notify the appropriate authorities to get this assistance.
8. **PPE and Decontaimination -** You will learn what PPE is appropriate for the involved material and what level of decontamination of persons and equipment is required. You will also learn how to perform decontamination and how to determine what equipment is required to properly perform decontamination.

CHAPTER TWO - TRANSPORTATION BASED CONTAINER SYSTEMS

Terminal Objective

By the end of this chapter, you will be able to recognize and identify the most common container systems used in road and rail transportation.

Enabling Objectives

By the end of this course, to a proficiency of 70%, you will be able to:

1. Given examples of the following cargo tanks, identify each cargo tank by type using shapes, markings, characteristics, and/or shipping papers:
   (a) MC-306/DOT 406 cargo tanks
   (b) MC-307/DOT-407 cargo tanks
   (c) MC-312/DOT-412 cargo tanks
   (d) MC-330/MC-331 cargo tanks
   (e) MC-338 cargo tanks
   (f) Dry bulk cargo tanks
2. Given examples of the following tank cars, identify each tank car by type using shapes, markings, characteristics, and/or shipping papers:
   (a) Nonpressure tank cars with and without expansion domes
   (b) Pressure tank cars
   (c) Cryogenic liquid tank cars
3. Given examples of the following intermodal tank containers, identify each intermodal tank container by type using shapes, markings, characteristics, and/or shipping papers:
   (a) Nonpressure intermodal tank containers
   (b) Pressure intermodal tank containers
4. Given examples of the following marked transport vehicles and their corresponding shipping papers, identify the vehicle or tank identification marking:
   (a) Rail transport vehicles, including tank cars
   (b) Intermodal equipment including tank containers
   (c) Highway transport vehicles, including cargo tanks
5. Given examples of transportation containers, identify the markings that differentiate one container from another.
6. Identify the location and describe the use of the mechanical, hydraulic, and air emergency remote shutoff devices as found on cargo tanks.

Road Trailers

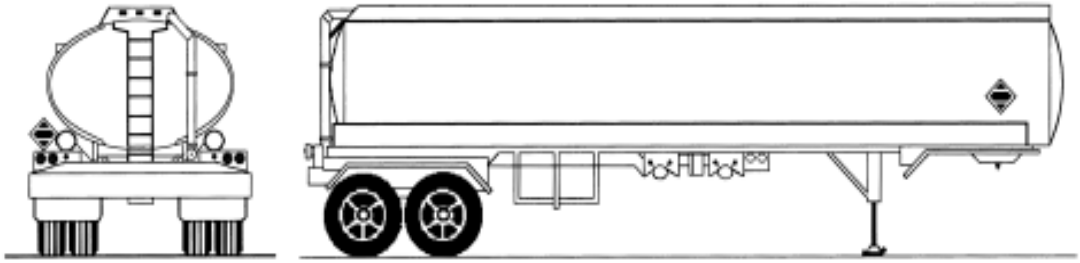
Introduction to Road Trailers

At the operations level, you are required to identify the presence of a hazardous material and the risks that the hazardous material present to the health of people, the environment and property. Understanding the shape, size, markings and shipping papers associated with the container systems that hold hazardous materials is important in the identification of the risks.

This chapter will cover these items for the most commonly used container systems on the roads, highways and rails of Kentucky. In this chapter, you will also learn about intermodal containers. These containers may be found on the roads, rails and even the waterways of Kentucky.

You have been taught to use signs as you approach a potential hazardous materials incident. Silhouetting, the practice of identifying a container system by its profile, is another method you can use to identify the presence of a hazardous material. In later chapters, you will learn how to take the skills you learn in this chapter and identify the hazards presented by the materials in these containers.

There are five basic types of container systems: flammable liquid, compressed gases, corrosive liquids, cryogenic liquids, and dry bulk containers. The United States Department of Transportation (U.S. DOT) outlines the specifications for both railcars and road trailers. It important to understand that shippers may decide to upgrade the level of containment required for a product. For example, a shipper may decide to ship a non-corrosive flammable liquid in a corrosive liquid container. Placards remain the one of the most reliable methods of identifying the presence of a hazardous material and must reflect the presence of a hazardous material regardless of the container.



DOT 406/MC 306 Non Pressure Liquid Tank

9,000 GALLONS CAPACITY
GENERAL PURPOSE CARGO

OPS Pressure Less Than 3 PSI
Typical Maximum Capacity 9,000 Gallons
New Tanks Aluminum
Older Tanks Steel
Oval Shape/Multiple Compartments
Recessed Manholes/Rollover Protection
Bottom Valves
Will Likely have Vapor Recovery.

Gasoline
Fuel Oil
Alcohol
Other Flammable/Combustible Liquids
Liquids
Liquid Fuel Products
(In Non-Coded Tankers)

MC-306/DOT-406 – Atmospheric Pressure Cargo Tanks

General Characteristics

These containers are the most popular cargo tanks on the roads of Kentucky and transport gasoline and diesel fuel throughout the state. This container is often described as a non-pressure vessel however, the term is misleading. While this container is not designed to be pressurized by an outside source i.e.: (compressor), it is designed to maintain pressures created by the products

and exterior temperatures. **Normally this is limited to less than 3lbs of pressure**. These containers may have a single compartment and often have **multiple compartments** with a **maximum capacity of 9,000 gallons**. Each compartment will have a corresponding dome lid on top of each compartment equipped with pressure relief devices, vapor recovery vents. The Dome lids on the MC-306/DOT-406 Cargo Tanks are typically secured with a mechanism known as a strong back or a swing bolt and wing nut latch.

Design Features

These tanks are easy to recognize from the rear due to the tanks oval or elliptical shape that normally extends over the wheel wells. From the side this tank may be identified by it's smooth exterior and the crash protection and vapor recovery system that often extends for the length of the vehicle. The majority of these tanks are equipped with curved blunt ends and a ladder at the rear of the tank to permit access to the dome lids. While the majority of these containers are constructed of aluminum, **older containers** may be constructed of **stainless steel and other materials.** The bottom of this container is outfitted with a series of internal valves and external valves used for loading and unloading. **Caution:** the unloading lines on MC-306 and DOT-406 may be charged with products.

The potential for a **Boiling Liquid Expanding Vapor Explosion, or "BLEVE,"** is minimal since aluminum will usually melt and burn to reveal the inner compartments before BLEVE can become a real threat. The melting of the container may also cause some product to leak out making control and containment a concern.

MC-307/DOT-407 - Low Pressure Cargo Tank

General Characteristics

These tanks are considered the workhorses of the chemical industry and carry of variety of chemicals including poisons, flammables, combustibles, mild acids, caustic solutions, and non-hazardous products.

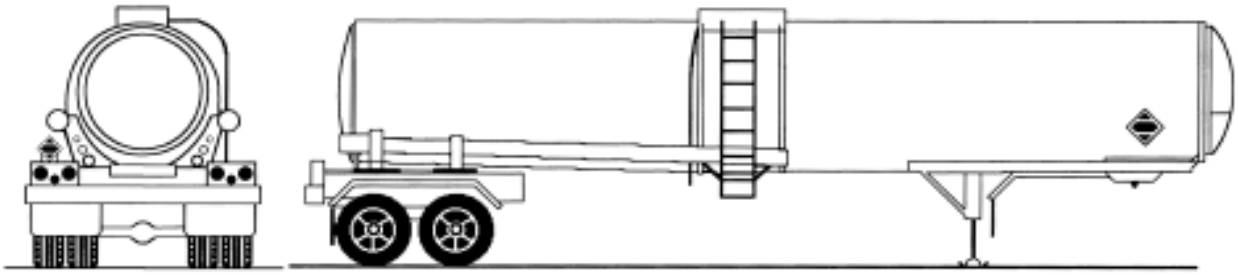
These containers are designed to be unloaded with pressure and may have design pressures of up to **40 psi**. The MC-307/DOT-407 may be single or **multiple compartment** units and normally has a **maximum capacity of 7,000 gallons**. Each compartment will have a corresponding dome lid on top of each compartment that is equipped with pressure/vacuum relief devices, a pressure gauge, and an air inlet/outlet . The Dome lids on the MC-307/DOT-407 Cargo Tanks are typically secured with a series of swing bolts and wing nuts that are screwed down manually to seal the tank.

Design Features

These tanks are normally smaller than the MC-306/DOT-406 Cargo Tanks and have a horseshoe or round shape when view from the front or rear. When viewed from the sided these tanks will have a crash box that protects each of its dome lids, relief devices, and other apparatus. These tanks may be insulated or uninsulated depending of the type of product they container. When viewing an uninsulated version of this container, the responder will immediately notice a series of circumferential strengthening rings that provide strength and support to the container. When viewing the insulated version of this tank the responder will only see a flexible outer jacket of polished sheet metal. This outer jacket is designed to maintain the integrity of the insulation is not

designed to hold product. The majority of these tanks are equipped with curved blunt ends and ladders on the side of the tank to permit access to the crash box and dome lids. While the majority of these containers are constructed of stainless steel, the may be constructed of other materials including aluminum, mild steel etc**.**

The potential for a **Boiling Liquid Expanding Vapor Explosion, or "BLEVE," is moderate to high.** Although aluminum tanks will usually melt, some tanks are made of **stainless steel will hold pressure** up to the point of a catastrophic container failure, BLEVE. Keep in mind that if a container melts, some product may be released making control and containment a concern.



DOT 407/MC 307 Low Pressure Chemical Tank

6,000-7,000 GALLONS CAPACiTY
TRANSPORTS CHEMICALS, FLAMMABLE AND COMBUSTIBLE LIQUIDS

OPS @ 25-40 PSI
Typical Maximum Capacity 6,000 Gallons
May Be Rubber Lined/Steel
Single or Double Top Manhole
Single Outlet Discharge for Each Compartment At Bottom (Midship Or Rear)
Typically Double Shell
Stiffening Rings
Rollover Protection
May Be Multiple Compartments
Horseshoe Or Round Shaped

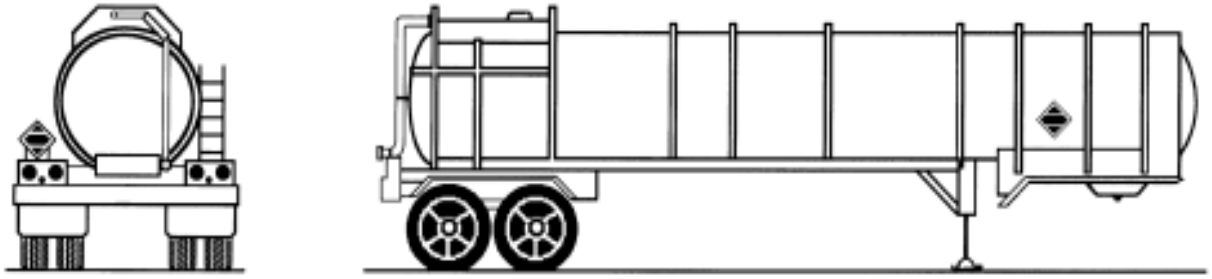
Flammable Liquids
Combusible Liquids
Acids
Caustics
Poisons

MC-312/DOT-412 - Corrosive Liquid Trailers

General Characteristics

These tanks are often referred to as "Acid Wagons" within the industry and normally transport a variety of acids and corrosive liquids. These containers are designed to be unloaded with pressure and may have design pressures of up to **100 psi**. The MC-312/DOT-412 is normally a single that has limited **capacity of 6,000 gallons**. However, multiple compartment MC-312/DOT-412 cargo tanks do exist the number of compartments is normally limited to a maximum of three (3) due to the limited capacity of the container. Each compartment will have a corresponding dome lid on top of each compartment that is equipped with pressure relief devices, a pressure gauge and air inlet/outlet.

The Dome lids on the MC-312/DOT-412 Cargo Tanks are typically secured with a series of



MC-312/DOT-412 Corrosive Liquid Tank

OPS Pressure Less Than 75 PSI
Typical Maximum Capacity 6,000 Gallons
May Be Rubber Lined/Steel
Stiffening Rings And Rollover Protection
Splash Guard Provides Rollover Protection
Top Loading At Rear Or Center
Loading Area Typically Coated With Corrosive Resistant Material
Small Diameter For Length (Tube Shaped)
Typical Single Compartment

Corrosive Liquids
Typically Acids

swing bolts and wing nuts that are screwed down manually to seal the tank. In some cases the dome on the tank may be bolted closed with a smaller opening in the dome lid that is used for loading

This tanks interior container and exterior loading platform may be lined with rubber or other materials to protect the structure and materials of construction used to manufacture the tank. These tanks are constructed of numerous materials including mild steel, stainless steel, aluminum, or a combination of fiberglass reinforced plastics.

Design Features

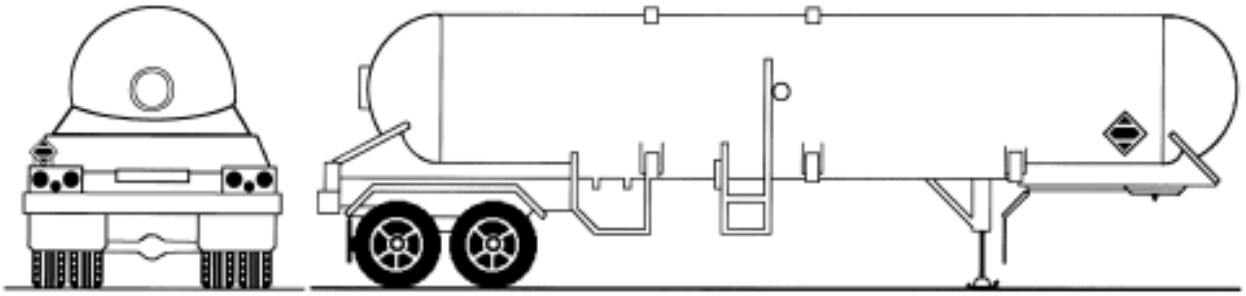
These tanks are a normally smaller in diameter when compared to other specification cargo tanks and barrel may barely extend over the wheel wells when viewed from the front or rear. Like the MC-307/DOT-407, these containers may be insulated or non-insulated depending on the product the tank is designed to transport. Likewise the strengthening rings may or may not be visible if the tank is insulated and like the MC-307/DOT-407 the purpose of the outer jacket is limited to maintaining the integrity of the insulation. Access ladders are typically located on the side of this tank and will permit responders to access the dome lids and relief devices. **Caution:** This container typically comes in two versions described as top unloading and bottom unloading units. Bottom unloading units are typically unloaded through internal valves on the bottom of the tank. Top unloading units utilize an internal standpipe that extends from the top of the tank to the bottom of the tank. This type of tank is typically unloaded pressurizing the vessel and forcing the product from the bottom of the tank into the internal standpipe and out of a valve on the topside of the container. Due to the extra plumbing, this tank may in fact be a single compartment tank with multiple crash boxes.

The potential for a Boiling Liquid Expanding Vapor Explosion, or "**BLEVE**," is moderate to high.

MC-331/MC-330 - High Pressure Trailers

General Characteristics

These tanks are the carriers of pressurized liquids and gases, including LP gas and anhydrous ammonia. Federal law requires that at least the upper 2/3 of these tanks be painted white, aluminum, or a similar reflective color. The **operating pressure of these tanks is usually up to 300 psi**. These tanks are a **single compartment** and a **typical maximum capacity of 11,500 gallons**. There is a single bolted manhole at the front or the rear of the container that is



MC-331 High Pressure Tank

11,500 GALLONS CAPACITY
TRANSPORTS LP GAS AND ANHYDROUS AMMONIA

OPS Pressure UP To 300 PSI
Typical Maximum Capacity 11,500 Gallons
Single Steel Compartment/Non Insulated
Bolted Manhole At Front or Rear
Internal and Rear Outlet Valves
Typically Painted White Or Other Reflective Color
May Be Marked Flammable Gas and Compressed Gas
Round/Dome Shaped Ends

Pressurized Gases & Liquids
Anhydrous Ammonia
Propane
Butane
Other Gases Liquefied Under Pressure

possibly in the **liquid space**. The tank is made of 1/2" to 1" thick steel.

Design Features

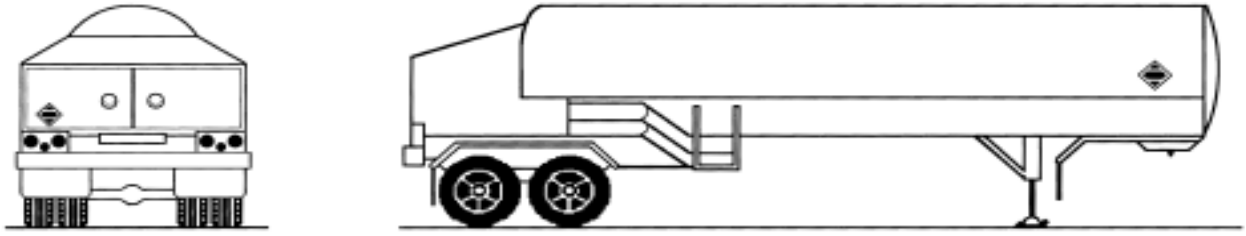
The MC-331/MC-330 are long, cylinders with evenly rounded ends. The tanks are usually not double-shelled. There is at least one, and sometimes two**, pressure relief valves** depending on the overall size of the tank. Each pressure relief valve is spring loaded, which means that they are self-closing. In addition the pressure relief valves are recessed into the tank top for rollover protection. On the bottom of the tank at the rear or midship, is a compartment that houses valves for on- and off-loading product. There is an emergency shutoff that may be mechanical (cable), hydraulic or air pressure actuated. There is an **identification and specification plate** located toward the front of the carriage frame on either side.

The potential for a Boiling Liquid Expanding Vapor Explosion, or **"BLEVE," is high**. Emergency shut-off valves are usually spring loaded and located near the off-loading ports and may be near the cab. By March 2001, all MC-330 and MC-331's that are used for delivery of LP Gas are supposed to have an automatic engine shut-off remote control. Many of the vehicles carrying LP Gas or compressed natural gas (CNG) will fuel the engine.

C-338 - Cryogenic Liquid Trailers

General Characteristics

These tanks are used to transport liquids that are at extremely low temperatures. The tanks are in a well-insulated "thermos bottle" design. They may be marked "Refrigerated Liquid." The **operating pressure is generally under 22psi.** These tanks are single compartments and



MC-338 Cryogenic Liquid Tank Truck

WELL-INSULATED 'THERMOS BOTTLE' DESIGN
TRANSPORTS LIQUID NITROGEN, OXYGEN CARBON DIOXIDE, ETC.

OPS AT Less THAN 22 PSI
Well Insulated Thermos Bottle Like Steel Tank
May Have Vapor Discharging from Relief Valves
Loading/Unloading Valves Enclosed at Rear
May Be Marked "Refrigerated Liquid"
Round Tank with Same Type of Cabinet at Rear

Liquid Oxygen
Liquid Nitrogen
Liquid Carbon Dioxide
Liquid Hydrogen
Other Gases That Have Been Liquefied by Lowering Their Temperature

rarely have a capacity greater than 7,000 gallons, although the tank may appear to be much larger than an MC-306/DOT-406. The construction of the tank may vary depending on the product to include stainless steel, bronze, or pyrex-lined stainless steel. However, the inner tank is most often made of 3/4" thick steel. The outer tank may be about 1/4" thick. The distance between the inner and outer tank is four to six inches.

Design Features

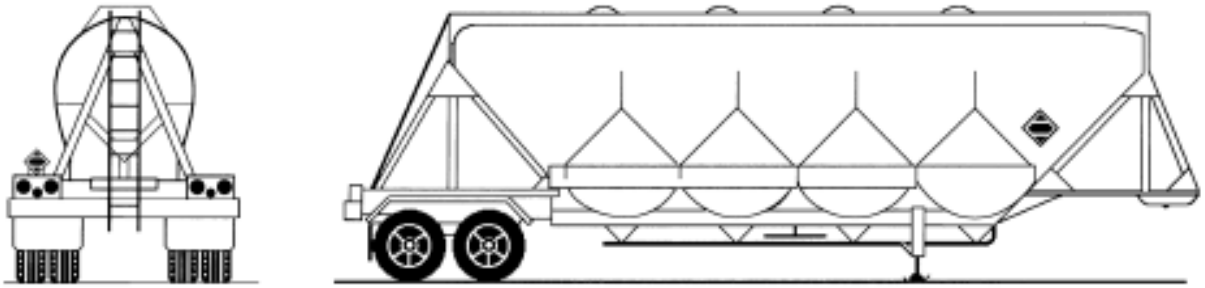
The MC-338 is double-shelled. There is a large "box" or compartment on the rear of the tank. This is where loading and off-loading controls and temperature, capacity, and pressure gauges are located. There is a frangible disk located on the top of the tank. Should the frangible disk rupture, it must be replaced because it is not self-closing. However, there may be a true pressure relief valve that would activate at 25 psi. There is an emergency shutoff that may be mechanical (cable), hydraulic or air pressure actuated, it is usually located in the compartment in the rear of the trailer, but also may be found near the front of the trailer near the cab. There is an **identification and specification plate** located toward the front of the carriage frame on either side.

The potential for a Boiling Liquid Expanding Vapor Explosion, or **"BLEVE," is high**. Emergency shut-off valves are usually spring loaded and located near the off-loading ports and may be near the cab.

Dry Bulk Cargo Trailers

General Characteristics

This category of trailer does carry hazardous materials as well. Often, these carry grains and other dry bulk materials. You may find explosives, flamable solids and class 6 materials. These trailers present an danger during the loading and unloading because in many cases high-pressure



Dry Bulk Cargo Tanker

OPS AT Less THAN 22 PSI
Typically Not Under Pressure
Over the Road
Top Side Manholes
Bottom Valves/Air Assisted Loading/Unloading
Shapes Vary, But Will Have Hoppers

Calcium Carbide
Oxidizers
Corrosive Solids
Cement
Plastic Pellets
Fertilizers

air is used. Also, the dust created when the trailer unloads can be a respiratory and/or explosion hazard if you are in the general vicinity.

Marking Systems for Cargo Trailers

The primary marking system on a cargo trailer is the identification and specification plate located on the lower part of the tank or on the carriage of the trailer. Figure 1.1 is an example of an identification and specification plate.

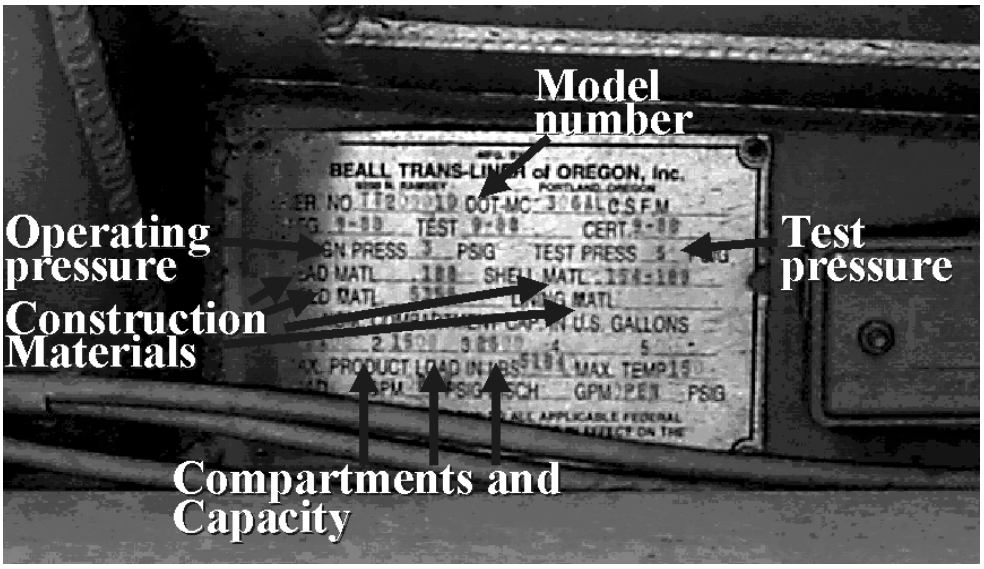
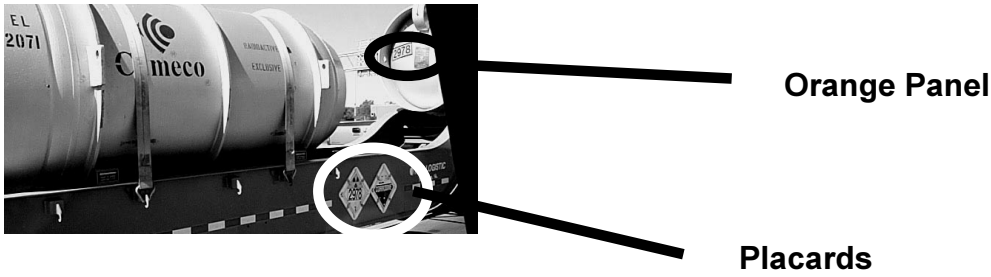


Figure 1.1

Placards and Orange Panels

When you were trained to the hazardous material first responder awareness level, you learned about the diamond-shaped placards used on both road trailers and rail cars to communicate the



presence of a hazardous material. The placards are required to be on each side of the container. In addition to the placards, you may encounter an orange panel with a (4) four digit number. This orange panel may have a second orange panel with a series of numbers or letters and numbers used to represent the specific hazard associated with the substance. With your student manual, you should have a DOT Chart 11 that provides you with further information about placarding.

Rail Cars

Daily, there are nearly 25,000 tons of hazardous materials shipped on the 2,500 miles of Kentucky railroads. As a first responder, you need to have a familiarization with the rail cars you might see on the tracks. Granted, there are some areas in Kentucky, such as Morehead/Rowan County where railroads are not present, however, in the event of a large-scale disaster, you may be called to assist in a jurisdiction that has a rail system. Therefore, knowledge of rail cars is important to hazardous materials response.

There are terms that you need to be familiar with in order to make a safe, effective, and efficient response to an event involving rail cars. **Rail cars have a point of reference**, the end of the rail car with the brake hand wheel, which is called the **"B" end**. When you are describing anything to someone concerning the rail car, always make reference to the "B" end of the car. This will help align assessments from different sides of the incident. Figure 1.2 on the following page illustrates identifying the ends of a railcar.

Because of the wide variety of products that are transported by rail, the rail tank car fleet has little standardization concerning the fittings and valves found on the non-pressurized and pressurized cars, **except for the chlorine service cars.** In this section, you will learn about the general characteristics and design of the rail car, and then you will learn about the types of fitting you may find on these cars. It is extremely important to understand that only the

chlorine service car is standardized. The U.S. DOT determines the specifications of the rail cars. The non-pressurized cars have model designations such as DOT-103 and DOT-111. Pay careful attention to the "DOT" designations, they will be important as you learn the rail car marking system.

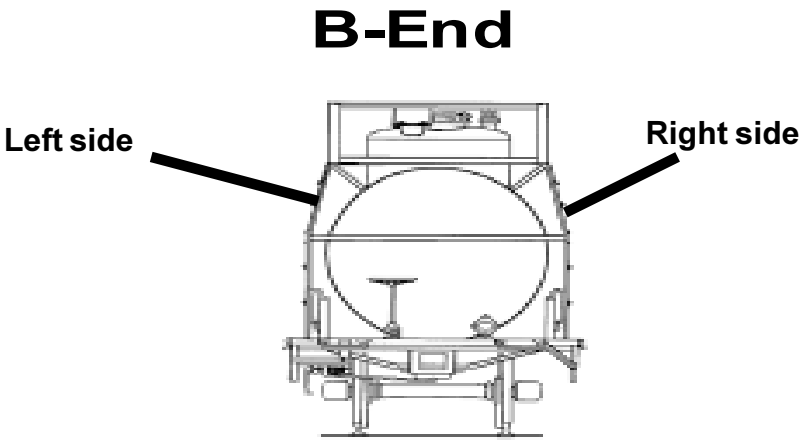
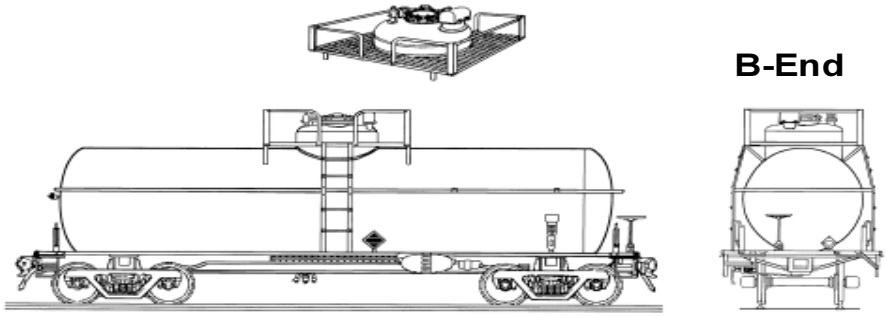


Figure 1.2

DOT 103 and DOT-111 - Non-pressurized (General Service) Rail Tank Cars

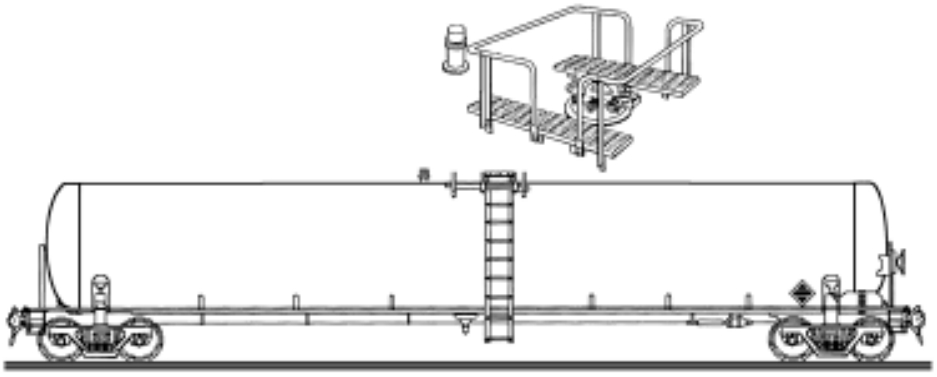
General Characteristics

The non-pressurized rail tank car is the workhorse of the rail tank fleet. Note that the term "non-pressurized" is misleading because these cars can have **up to 100 psi**. This is why the rail industry refers to this as the "general service" tank car. This car can transport flammable and combustible liquids, poison liquids, corrosive liquids, oxidizers, peroxides, foodstuffs, and solids in molten form. This tank can have a **capacity ranging from 4,000 gallons to over 29,200 gallons.**

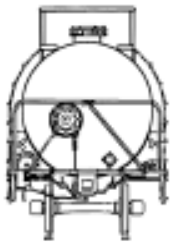


Design Features

The general service cars are not less than 7/16" thick, but may be thicker. They may be made from aluminum or steel, depending on the product being transported. In addition, these cars may be rubber or wax lined. The **DOT-111** typically has a **low profile "manway,"** or large opening often used for loading and unloading, and access for purging and cleaning the car. Most of the loading and unloading fittings, if there are any, are located around the manway.



B End



DOT 111 General Service Car

26,000 GALLON CAPACITY - NONINSULATED
DOT 111A100W1
FOR GENERAL SERVICE COMMODITIES
.2181"/FT TOP & BOTTOM SLOPE

Non-Insulated or Insulated.
Safety Valve (75 psi) or Safety Vent (100 psi).

Kerosene,
Gasoline, Fuel Oil,
Vegetable Oils,
Phosphorus

The **DOT-103** has an **expansion dome**, which makes it easy to recognize. The expansion dome provides additional space for the product to expand while in transportation without overpressuring the car causing the safety relief device to function. Most of the fittings used for loading and unloading are located on the expansion dome.

The DOT-103 and DOT-111 may have bottom outlets for unloading. These cars may also have interior or exterior heater coils and may be insulated.

Fittings for the Non-Pressurized (General Service) Rail Tank Cars

The fittings on a rail car will depend on the product being transported. Some general service cars use a safety relief device called a **safety vent** that may be a **frangible disk**. A frangible disk, also called a **rupture disk**, will not reset after the disk has ruptured. Other general service cars may be equipped with a spring-loaded **safety relief valve, SRV**. This use of a safety relief valve instead of a safety vent will depend on the product being transported. Cars equipped with a safety vent may not be used to transport flammable liquids and must be stenciled "NOT FOR FLAMMABLE LIQUIDS."

The manway is equipped with a gasket that is prone to failure due to wear, overtightening, contamination by the product, or many other complications. Near the manway will be a vacuum relief valve, a mushroom-shaped device that may open on its own or may be depressed to relieve a vacuum, that may literally suck the car in on itself. There may be an air connection valve that is used to provide air pressure to unload the product.

On the bottom of the car may be a valve used for washout of the car or unloading product. However, most cars used to transport acids will not have this feature. These valves may be activated from a stuffing box on the top of the car, near the manway, or by remote activators on the bottom of the car, near the outlet. The fittings on a general service car will vary based on the product and use of the car.

Finally, the general service car may have a heater (steam) coil around the tank. This is used when a product may need to be heated to off-load. This may be a source of a possible leak, but is also a danger because of the steam heat and possible pressure. The coils encase the tank. And often have outlets at the bottom of the car.

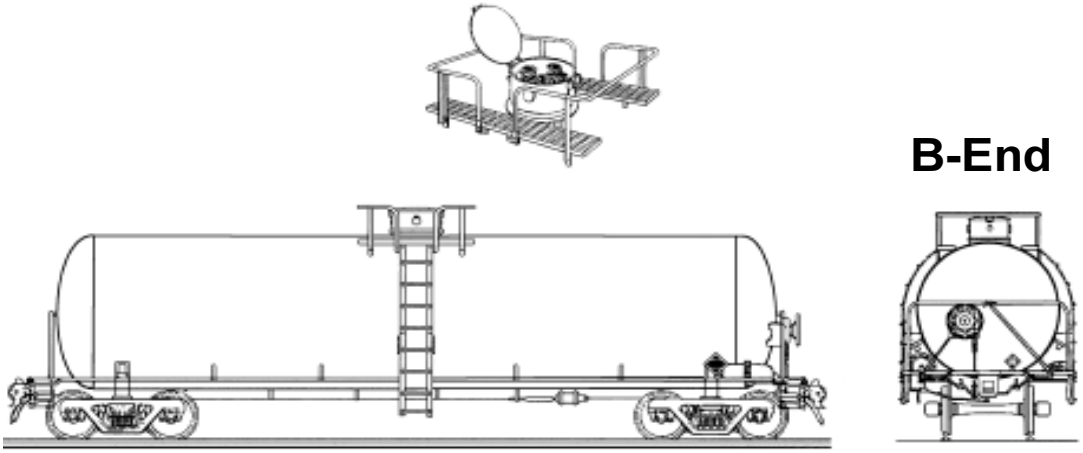
DOT 105 and DOT-112 - Pressurized Rail Tank Cars

General Characteristics

Pressurized tank cars are highly used on the rails today. These cars may be used to transport liquefied gases and other highly hazardous materials and may operate at pressures **up to 600 psi**. This tank can have a **capacity of 90 tons of chlorine or ranging from 20,000 gallons to over 33,500 gallons of other products.**

Design Features

Pressure cars can be distinguished from non-pressurized cars by the fact that **all unloading**



DOT 105 - Chlorine Service

90 TON CAPACITY - INSULATED
DOT 105A500W
FOR CHLORINE SERVICE
(POST 1982)

Insulated. Safety Valve (375 psi)

Chlorine
Carbon Dioxide (350 psi)
Anhydrous Hydrofluoric Acid

Liquefied Petroleum Gas
Liquefied Hydrocarbon Gas

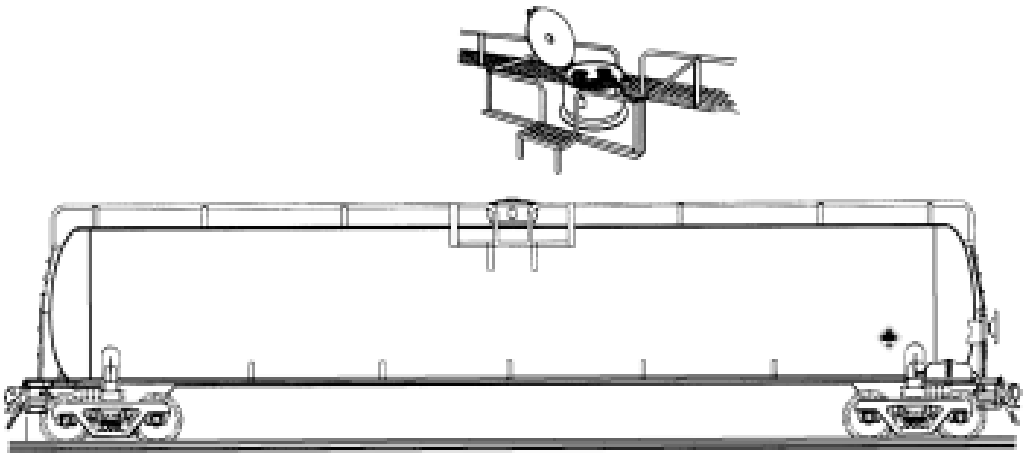
Fertilizer Ammoniating Solution
(Ammonium Nitrate Solution)

and loading valves are in one location on the top of the car. These valves and fittings are protected by a **housing.** There are no bottom outlets on these cars, nor is a fitting permitted outside the protective housing.

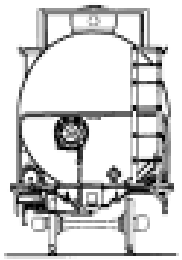
These rail cars are made from steel or aluminum, depending on the product being transported and range from 1/2" to 1" thick. These rail cars are **thermally protected or jacketed.** Jacketed thermal protection is different from insulation, in that it protects the actual tank from external heat, such as with a fire under the car (**pool fire**) or a blow-torch-type flame (**direct flame impingement**.) The jacket is held in place by an external shell. **Thermal protection is sprayed**

on the outer surface of the tank or shell. This thermal protection protects the car by expanding to nearly two inches on exposure to the fire.

These rail cars are insulated with foam, cork, fiberglass, or ceramic fiber and have an exterior



B-End



DOT 112 - LP Gas Service

33,500 GALLON CAPACITY - NONINSULATED
DOT 112J400W
FOR PROPYLENE, LIQUEFIED PETROLEUM GAS AND ANHYDROUS AMMONIA SERVICE

LP Gas
Propylene
Anhydrous Ammonia
Vinyl Chloride

metal jacket that protects the insulation. These cars are equipped with a spring-loaded SRV or SRV/safety relief vent combination. The **safety relief device is usually set to function at 75% of the car's test pressure**. The liquid and vapor valves may be equipped with excess flow valves to stop product flow if they are sheared off in a derailment.

Some pressurized cars may be used to transport carbon dioxide or other liquefied atmospheric gases. **These cars are equipped with pressure regulators that will periodically activate during transportation to relieve internal pressure.** The cars must be marked to denote they may vent during transportation.

The pressure tank car will also have **top and bottom shelf couplers**. These prevent another rail car from puncturing the tank during coupling. The pressure tank car will also have **head shields** that provide additional collision protection on the ends of a tank car. **Older cars will have visible head shields**; while **newer tank cars will have the head shields built in** and are not detectable by visual inspection.

Fittings for the Pressure Rail Tank Cars

The fittings on a pressure car are inside the protective housing. Many times, there is not a standard layout for the fittings, except in chlorine service cars. Usually, you will find at least one **vapor valve and a liquid valve**. These valves are used for loading and unloading the product.

The valves may be ball type valves or stem type (angle) valves. Ball valves are usually short with an on or off position. Stem valves have a hand wheel on them and require multiple turns to open or close the valve. In chlorine service cars, the liquid line valves are situated on the long axis of the rail car, while the vapor valves are located on the short axis of the rail car.

In addition to the valves, you may find a great deal of other hardware in the protective housing. The rail industry uses thermometer kept in wells (**thermometer wells**) often filled with an antifreeze solution. In addition to the thermometer wells there are **sample tubes**, used by the receiver of the product to obtain a sample of the product without opening the tank and contaminating the load. In a collision, these wells and tubes may crack or break causing an accidental release of product. Each of these has a series of small holes made in the threads to allow the release of pressure. This release should alert you of a possible break in the tube. If **you hear a hissing sound as you loosen this cap, tighten the cap back on and alert other response personnel**.

There are **gauging devices called slip-tubes** used to determine the amount of product in the car. These may be magnetic or a solid rod with measurements stamped on the rod. These devices may also break creating a release of product. Like the thermometer wells, if you loosen the cap and hear a hissing sound as you loosen the cap, retighten the cap and alert other response personnel.

DOT 113 - Cryogenic Rail Tank Cars

General Characteristics

The cryogenic tank cars are to transport liquids at extremely cold temperatures such as liquefied ethylene, liquefied oxygen or liquefied hydrogen. They may operate at pressures **25 up to psi**. The cars range in **capacity from 4,000 gallons to 30,000 gallons**.

Design Features

The cryogenic car is a tank within a tank with a layer of insulation between the two layers. The inner tank may be constructed of stainless steel, aluminum, or a copper/bronze alloy and may contain materials that have a temperature of **-423° F**. The outer tank is usually 1/4" steel. **Shipments are time sensitive**, even though the car is supposed to protect the product with little loss for 30 days. Therefore, if a car has been setting in a yard for an extended period of time, there may be cause for alert.

There are **no controls on the top of this tank car** and the car has **slightly convex (rounded) ends**. The loading and unloading controls are in a compartment located on the lower side of the rail car. The controls are stem-type valves that can be operated by individuals wearing heavy-duty gloves. However, there may be vent tubes and/or a platform arrangement on top of the car. These rail cars have a **safety vent (frangible disk) and safety relief valve (SRV) combination.**

Rail Car Identification Markings

The markings on a tank car can provide you with a great deal of information about the car, and ultimately about the potential threat posed by the material in the car. The rail tank car number is an identifier that can be used by the rail company, CHEMTREC, and the consignee to determine the contents of the rail car. The tank car specification numbers provide you information about the make of the car which will give you information about the materials that car may carry. It is important to understand what these numbers are and how to use them so that you will be able to detect the

Left side of the rail car

Right side of the rail car

presence of hazardous materials.

Rail Tank Car Number

When facing the side of an **upright rail car**, the rail tank car number is an **alphanumeric number located on the left side of the car**. The number is usually four letters, which indicates the owner of the rail tank car. The five numbers that follow are the owner's marking. **When you obtain this number WRITE IT DOWN**.

Tank Car Identification Markings

The tank car specification numbers are stenciled on the right side of an upright tank car. Table 1.1 on the opposite page provides an example of the tank car specification numbering system.

DOT	111	A	60	AL	W	1
AUTHORIZING AGENCY	**CLASS DESIGNATION**	**SEPARATOR CHARACTER**	**TANK TEST PRESSURE (PSI)**	**TYPE OF MATERIAL USED IN TANK CONSTRUCTION**	**TYPE OF WELD USED**	**OTHER CAR FEATURE**
Tank car specifications start with three letters designating the agency under whose authority the specification was issued **•DOT - Department of Transportation** **•AAR - Association of American Railroads** **•ICC - Interstate Commerce Commission (Regulatory Authority Assumed by DOT in 1966)** **•CTC - Canadian Transport Commission**	The Three Digit Class Designation Follows the Authorizing Agency •Non-Pressure Tank Cars •Pressure Tank Cars •Cryogenic Liquid Tank Cars •Miscellaneous Tank Cars	Significant only for Class 105, 113, 114 Tank Cars and Some 111 Tank Cars When Retrofitted. "A" - Top and Bottom Shelf Couplers "S" - Tank Headshields, Top and Bottom Shelf Couplers "J" - Jacketed Thermal Protection, Tank Headshields, Top and Bottom Shelf Couplers "T" - Spray-On Thermal Protection, Tank Headshields, Top and Bottom Shelf Couplers		"No Letter" - Carbon Steel "AL" - Aluminum (Classes 103, 105, 109, & 111) "A-AL" - Aluminum Alloy "N" - Nickel "C", "D" or "E" - Stainless Steel (Alloy/Steel)	"W" - Fusion Welding "F" - Forge Welding	Fittings, Materials, Linings

Table 1.1

Intermodal Container Systems

General Characteristics

Intermodal containers may be transported on road, rail, air or water. These containers are in three different forms; non-pressure, pressure and cryogenic. The tank characteristics are similar to their road and rail counterparts. However, most tanks are encased in a steel frame so they may be stacked on one another. These may be placarded with the either or both the DOT placard system and the orange panels mentioned above.

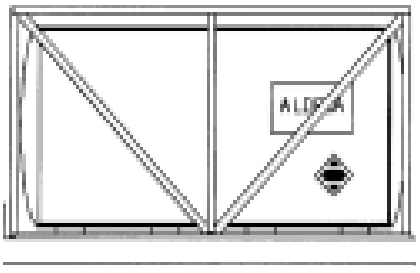


Figure 1.3
Pressurized Intermodal Container

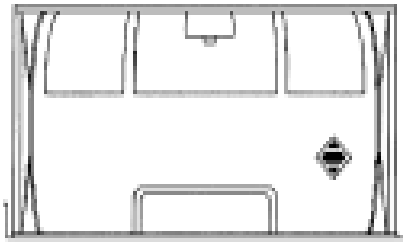


Figure 1.4
Cryogenic Intermodal Container

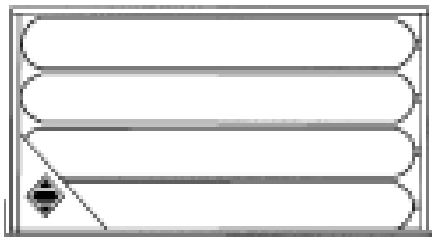


Figure 1.5
Tube Intermodal Container.

CHAPTER THREE – FIXED FACILITY AND NON-BULK CONTAINER SYSTEMS

Terminal Objective

By the end of this chapter, you will be able to recognize and identify facility based and non-bulk containers.

Enabling Objectives

By the end of this course, to a proficiency of 70%, you will be able to:

1. Given examples of the following facility tanks, identify each fixed facility tank by type:
   (a) Nonpressure facility tanks
   (b) Pressure facility tanks
   (c) Cryogenic liquid tanks
2. Given examples of the following nonbulk packages, identify each package by type:
   (a) Bags
   (b) Carboys
   (c) Cylinders
   (d) Drums
3. Given examples of facility containers, identify the markings indicating container size, product contained, and/or site identification numbers.
4. Identify the following information on a pipeline marker:
   (a) Product
   (b) Owner
   (c) Emergency telephone number

Introduction to Fixed Facility Based Container Systems

In Kentucky, **over 5,000 fixed facilities store or manufacture hazardous materials**. Whether it is the Marathon-Ashland Petroleum refinery in Ashland/Cattletsburg (Boyd County); the Atochem Plant in Calvert City (Marshall County); Louisville Gas and Electric's E.B. Brown Generating Plant near Burgin (Mercer County); or even the Appalachian Regional Healthcare Center in Middlesboro (Bell County), there are hazardous materials present. Included in the 5,000 facilities are **nearly 1,500 facilities that house extremely hazardous materials.**

In these facilities, several different types of containers are used**. The type of container used will depend on the amount of the material, the type of the material and even the use of the material**. In this chapter, you will learn about the different types of containers and container systems used primarily in fixed facilities. These are divided into two types of systems, **bulk and non-bulk**. It is important to keep in mind that the **non-bulk containers may be used in transportation** as well as a fixed facility.

Bulk Facility Containers

As with the container systems used in transportation, there are divisions in above-ground fixed facility containers: atmospheric (non-pressure), low pressure, pressure, and cryogenic containers. The volume of the fixed facility containers is often much greater than the containers used in transportation. As a first responder at the operations level, **it is important that you understand**

and recognize the difference in pressure and non-pressure tanks.

Atmospheric (non-pressure) Tanks

Atmospheric tanks, which may also be called non-pressure tanks, are designed for pressures of 0 to 0.5 psi. Several different tanks meet this criterion: **Ordinary Cone Roof Tanks, Floating Roof Tanks, Lifter Roof Tanks and Vapor Dome Roof Tanks**.

The ordinary cone roof tank is an enclosed tank. The floating roof tank is a tank where the roof deck rests on the rests upon the liquid and moves upward and downward with changes in the liquid level. Often, the floating roof tank can be identified by the "eye-brow vents." **Both of these tanks usually hold liquid products.**

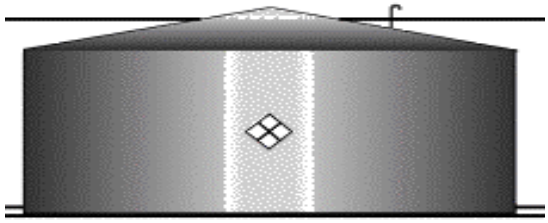


Figure 2.4 Cone Roof Tank

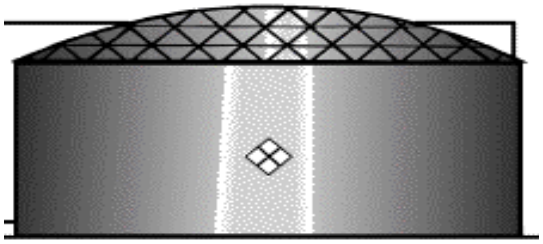


Figure 2.5 Vapor Dome Roof Tanks

The lifter roof tank is a sealed tank that has a roof that moves upward and downward depending on changes in the **vapor volume.** The tank is easily recognized by the exterior tank skeleton. Vapor dome roof tanks have **a flexible diaphragm in the hemispherical (rounded) roof**. This diaphragm moves up and down with changes in the **vapor volume**.

Low Pressure Tanks

Low-pressure storage tanks are normally used for vapor conservation purposes requiring storage of materials at pressures of 0.5 to 15 psi. Low-pressure tanks usually have greatly pronounced rounded tops.

Pressure tanks

Pressure vessels are usually used for vapor conservation purposes requiring storage of materials

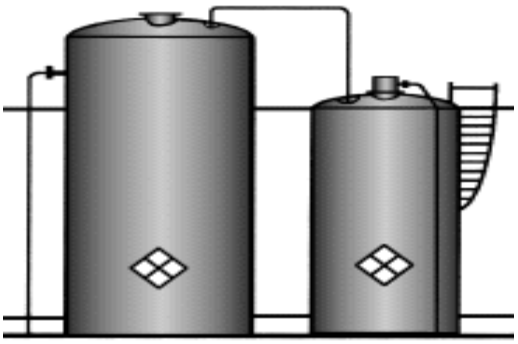


Figure 2.6 Low Pressure Tanks

at pressures above 15 psi. These tanks often hold flammable gases or toxic gases such as LP gas, chlorine and anhydrous ammonia. These tanks may look like a large sphere or a long

cylinder with rounded ends. The cylindrical tanks may appear similar to the transportation style pressurized vessels.

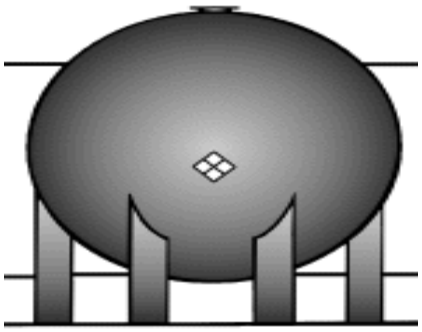


Figure 2.7
Spherical Pressure Tank

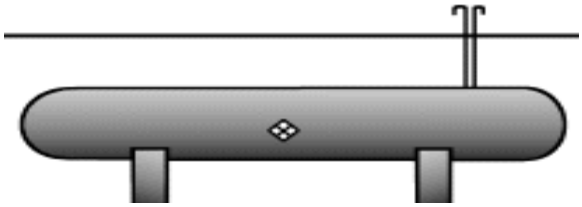


Figure 2.8
Horizontal Pressure Tank

Cryogenic Liquid Tanks

Cryogenic Liquid Tanks are used for on-site storage and supply. They have a definite look. Essentially, they look like the rail cryogenic tank cars, however, they may be vertically or horizontally mounted. You will often find these tanks near hospitals, since these tanks are used for storing and supplying oxygen.

Markings for Fixed Facility Containers

As you learned at the awareness level, you might find several different marking systems at a fixed facility. The National Fire protection Association's (NFPA) 704 Marking system is used exclusively on fixed facilities, although it's use is not mandated. The hazardous materials identification system (HMIS) is another alternative you may find used to mark the presence of a hazardous material. You may also find the placards used in transportation to mark the presence of a hazardous material at a fixed facility. 29 CFR 1910.1200, the Hazard Communication Standard issued by OSHA states that the hazards presented by a material must be communicated to workers. In this section, you will review the NFPA 704 and hazardous materials identification system (HMIS).

NFPA 704 Marking System

The NFPA 704 Marking System is a system that uses numbers on colored diamond shapes to **convey the level of hazard a material presents**. The numbers range from 0-4; the **higher the number, the greater the danger.** The blue diamond, located on the left side of the symbol,

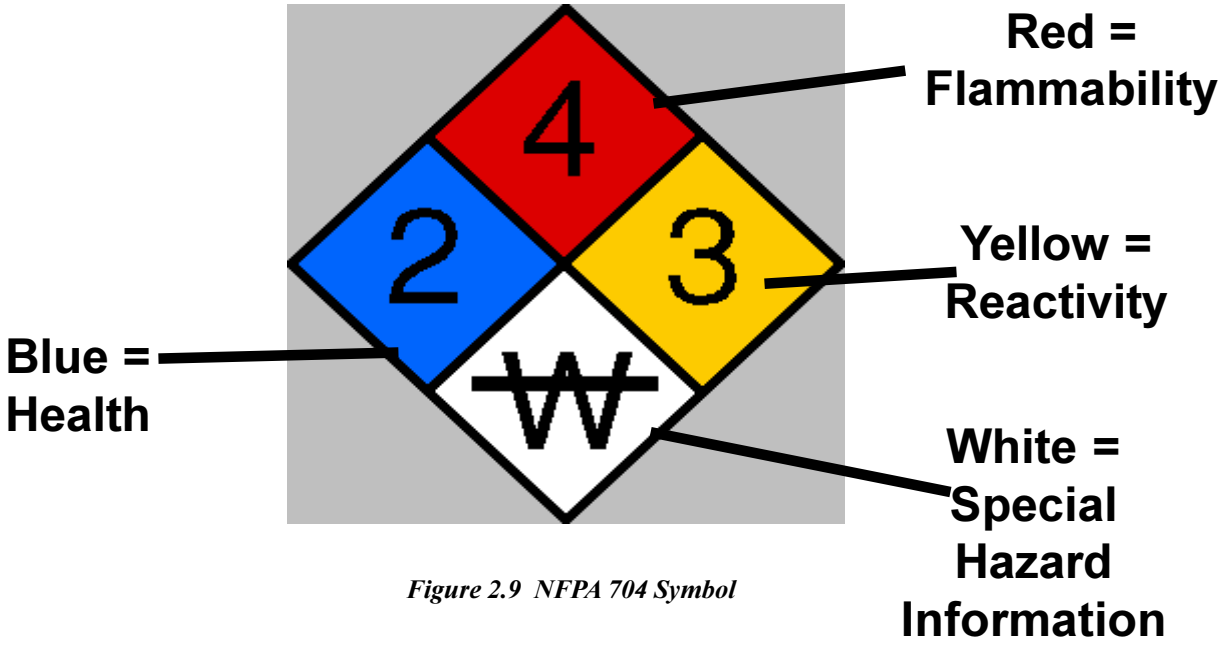


Figure 2.9 NFPA 704 Symbol

indicates the health hazard. The red diamond located at the top of the symbol represents the flammability hazard. The yellow diamond is located on the right side of the symbol conveys the reactivity of a product. Finally, at the bottom of the symbol is a **white diamond that explains special considerations** of the product. See Figure 2.9 for an illustration of the NFPA 704 Symbol.

Hazardous Materials Identification System (HMIS)

This system was developed by the National Paint and Coating Association to address situations more common to their environment than the situations encountered by firefighters. In many respects, **the HMIS is very similar to the NFPA 704 system**. The **color and number coding are identical**. Instead of using a diamond, the **HMIS uses a color bar system**. However, in this system, the white section is used to indicate what level of protective equipment is required. Instead of a hazard ranking, a level of protection is indicated by a letter, with each letter specifying a different level of protection. See figure 2.10 for an illustration of the Hazardous Materials Information System.

Non-Bulk Containers and Containers for Pressurized Gases

There are various small containers used to store and transport hazardous materials around the state. At the awareness level, you learned to recognize these containers. However, as a hazardous

Figure 2.10
The HMIS Label

A	safety glasses
B	safety glasses and gloves
C	safety glasses, gloves and an apron
D	face shield, gloves and an apron
E	safety glasses, gloves and a dust respirator
F	safety glasses, gloves, apron and a dust respirator
G	safety glasses, a vapor respirator
H	splash goggles, gloves, apron and a vapor respirator
I	safety glasses, gloves and a dust/vapor respirator
J	splash goggles, gloves, apron and a dust/vapor respirator
K	airline hood or mask, gloves, full suit and boots
L - Z	custom PPE specified by employer

Table 2.1

materials first responder at the operations level, you should be familiar with the design features of these containers. It is important to understand that **non-bulk containers may be used to contain different types of hazardous materials**. For example, 55 gallon drums may be use to contain hazardous waste or a toxic or a flammable liquid. **Always use the shipping papers, labels or placards to identify the contents of a container**.

Containers for Pressurized Gases

As mentioned in chapter 1, containers that are used to transport pressurized gases have a distinctive look with the rounded ends. In addition, these pressure containers are constructed from heavy gauge steel and have valve assemblies and pressure relief valves.

This holds true for the smaller cylinders. These cylinders are usually referred to by weight or by a letter designation. If you are a first responder, EMT or Paramedic, you are familiar with the “D” size cylinder that is commonly used as part of a portable oxygen delivery device. The large bottles (cylinders) used inside an ambulance is called a “K” or “L” cylinder. This is also known as a 150-pound cylinder.

Although there is no standard color coding system for cylinders, the tops of these cylinders are green. Usually, the smaller oxygen bottles are made from aluminum and the lower part of the bottle may have a shiny finish, however, the top of the bottle, excluding the stem, will be green. The only way to positively identify the contents of the cylinder is to read the label or stencil on the cylinder or check the shipping papers.

When these and larger cylinders are transported, they are often transported on cargo type trucks, flatbed trucks and stake sides.

Containers that are **less than ½ gallon** are usually not meant for refill. You will recognize these cylinders as the type used to hold **flammable gases** for torches. Besides flammable gases, these can also hold **toxic gases** such as methyl bromide. These cylinders are usually made from steel. **The safety device of this type of cylinder is a melt-away fusible plug.**

The next size containers hold from **1 to 20 gallons**. The best example of this type of cylinder is the cylinder used under the household propane grill. These bottles have the **distinctive round**

Small Pressurized container.

20 gallon Pressurized Container

50 gallon (100 to 150 Pound) Pressurized Containers

top with the valve assembly at the top. These are designed for refill. The safety device for this type of cylinder is either a **pop-up pressure relief valve or a fusible plug.**

Cylinders with a capacity of **20 to 50 gallons** are upright cylinders that range from two **(2) to five (5) feet tall and 8 to 12 inches in diameter**. These are the most common cylinders in use. As mentioned above, they are often **referred to by weight, usually 100 or 150 pound cylinders**.

300 gallon (1 Ton) Pressurized Containers

The **valve stem is at the top** with a screw-on valve cap. It is important to note that the **valve assemblies for each gas are unique**. The threads and connections are different depending on the gas. This prevents accidental loading of a gas in the wrong tank. **Valve stems have a melt-away fusible plug** that acts as a pressure relief valve. However, **these devices do not self-close**. Also, **some toxic gases do not have pressure relieving features** because their toxicity poses a greater risk than does the BLEVE hazard.

Containers that range in **capacity from 50 to 200 gallons** are commonly called pigs. They are most **often found in LPG powered vehicles**. They may be **found in trunks or a pickup bed**. They will have a **recessed, concave top where the valves are located**.

One ton (about 300 gallons) containers are often **found around water and sewage treatment facilities**. These containers are about **¾ inch thick steel** tanks used for **anhydrous ammonia, chlorine, and sulfur dioxide**. They too have a distinct look, however it is different from the other types of containers**. One end has three (3) valve stem assemblies with three (3) melt-away fusible plugs**. The opposite end has three (3) melt-away fusible plugs.

Flammable Liquid Containers

Containers for flammable liquids are usually recognizable by their flat, blunt ends. These containers do not have any pressure relief devices, but do often have spouts and removable caps for unloading a product. Construction is usually aluminum, steel or often a heavy-duty plastic. The best method of identifying the product within is through labels or placards, or the shipping papers (if in a transportation situation.)

Flammable Liquid Containers

These containers may be shipped in local delivery trucks, flatbeds, cargo type trucks or boxcars. Smaller containers are often shipped in cardboard boxes.

Containers may range in size from less than a gallon up to 5 gallons. If a container is over 5 gallons, it is often considered to be a drum. Drums usually are from five (5) to 55 gallons. They are usually constructed out of metal; however, plastic drums are increasing in use. They are usually round, but may be rectangular. Any type of liquid may be transported in these containers. Again, refer to the labels, placards and shipping papers to determine the contents of the drums.

CONTAINERS FOR CORROSIVE AND TOXIC LIQUIDS

Containers for corrosive and toxic liquids use the same type of steel and plastic containers used

A carboy.
Note the HMIS symbol on the label.

55 gallon drums may carry nearly any kind of liquid or solid. Use the labels and shipping papers to determine the contents.

for flammable liquids. Often, "**carboys**" are used with these types of liquids. **Carboys are glass bottles usually in either one (1) or five (5) gallon sizes**. They may be packaged in styrofoam or other protective wrap then inside a cardboard box to protect the glass during shipping. Containers that hold toxic or corrosive substances must be labeled as such. Do not assume that a non-bulk container is specific type of material; use the labels, placards and shipping papers to identify the contents of a container.

Containers for Corrosive and Toxic Solids

Corrosive and toxic liquids are found in granular, pellet or powder form. These materials may be shipped in drums or bags ranging from ½ to 100 pounds and are often shipped in cardboard boxes or on pallets.

Pipelines

Pipelines are a concern for responders in the Commonwealth. They are present in almost every county in the state. There are markers that provide the name of the substance in the pipeline, and an emergency contact number.

Section 2 - Estimate Likely Harm Without Intervention

CHAPTER FOUR - PREDICTING THE BEHAVIOR OF A MATERIAL

Terminal Objective

By the end of this chapter, you will be able to reasonably predict the possible behaviors of a material and container systems used in facilities and transportation.

Enabling Objectives

By the end of this course, to a proficiency of 70%, you will be able to:

Material behavior

1. Match the following chemical and physical properties with their significance and impact on the behavior of the container and/or its contents:
   - (a) Boiling point
   - (b) Chemical reactivity
   - (c) Corrosivity (pH)
   - (d) Flammable (explosive) range (LEL & UEL)
   - (e) Flash point
   - (f) Ignition (autoignition) temperature
   - (g) Physical state (solid, liquid, gas)
   - (h) Specific gravity
   - (i) Toxic products of combustion
   - (j) Vapor density
   - (k) Vapor pressure
   - (l) Water solubility
2. Identify the differences among the following terms:
   - (a) Exposure and hazard
   - (b) Exposure and contamination
   - (c) Contamination and secondary contamination

Container behavior

3. Identify three types of stress that could cause a container system to release its contents.
4. Identify five ways in which containers can breach.
5. Identify four ways in which containers can release their contents.
6. Identify four dispersion patterns that can be created upon release of a hazardous material.

MATERIAL BEHAVIOR

Introduction to Material Behavior

As a first responder to hazardous materials incidents, you need to be alert to the behavior of a material and the containers that hold them. In the first section of this course, you learned about the container systems, their general construction and design features. You will learn about the physical and chemical characteristics of chemicals. You will learn how those characteristics might affect the containers that hold them. You will also learn about physical and chemical characteristics you should be concerned about as you respond to an incident. Finally, you will learn about the results of container failure, also called a breach.

Fire Triangle and Fire Tetrahedron.

The fire triangle and fire tetrahedron are important concepts to grasp so that you can understand the full threat of a hazardous material, whether you are a firefighter or a fish and wildlife enforcement officer. The determination on whether the fire triangle or fire tetrahedron applies depends greatly on the type of combustion that is taking place. For this course, it is important that you understand both theories.

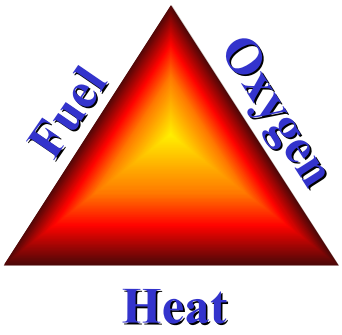


Figure 3.1 The Fire Triangle

Fire Triangle

The fire triangle is a simple, but important theory that provides the recipe for fire. Essentially, fire, also known as combustion, is the chemical change of a substance through rapid oxidation with an exothermic release. This definition translated means that a substance is chemically changed by combining it with oxygen through heat.

There are three (3) elements to this process: fuel, oxygen and heat. If you remove any one of these elements, you have stopped the fire. If you prevent these elements from coming together, you have prevented a fire. Figure 3.1 shows the fire triangle.

Fire Tetrahedron

The fire tetrahedron adds an additional element to the process of combustion. In the fire tetrahedron, there are four elements: heat, oxygen, called an oxidizing agent; fuel, called a reducing agent; and an uninhibited chemical chain reaction. As with the fire triangle, if you remove any of the elements, or interrupt the chemical chain reaction, then you have stopped the combustion process. If you prevent the elements from coming together, then you have prevented a fire.

FIRE TETRAHEDRON

Terminology

Introduction to terminology

As a first responder, you know that there is a certain amount of terminology that is specific to the area that you are involved in. You can nearly match terms like myocardial infarction, B.L.E.V.E., flashover, and assault to the services that would respond to each. This is no different for hazardous materials response. In the back of this book is a glossary that is full of terms used in this field. There are several other reference materials that you can use to learn the definitions. Hawley's Condensed Chemical Dictionary is possibly the most comprehensive dictionary designed especially for the chemistry field.

In this section, you are going to discover several terms that are important to further understanding how a hazardous material is a threat to your health, the environment, or to property. By learning these terms, and how they apply to a material, then you will be better prepared to predict how a

material will act when released.

Boiling point – The boiling point of a liquid is the **temperature at which a liquid becomes a gas.** In technical terms, it is when the vapor pressure is equal to or slightly greater than the atmospheric pressure of the environment. The best illustration of this is when **water turns into steam**. The boiling point of water is 212° F (100° C). When a substance boils, it may cause increased pressure on the container of the vapors are not allowed to escape.

Chemical reactivity – The chemical reactivity of a substance is the **relative degree or sensitivity of the material to release energy by either itself or when it combines with other substances.** In the awareness level course, you learned about materials that polymerize, or react with themselves; this would be an example of a high level of chemical reactivity. This process often causes heat and may increase the pressure in a closed container.

Corrosivity (pH) – The corrosivity of a substance is the ability it may have to **visibly alter or damage human tissue at the site of contact or to eat away steel at a highly accelerated rate**. Corrosive materials are usually classified into two (2) groups, **acids and alkalis**. Corrosivity is measured in terms of pH ranging from 0 to 14. Any substance with a **pH of 0-6 is considered to be acidic**. Any substance with a **pH of 8-14 is considered to alkaline.** Hydroxides such as sodium hydroxide are alkaline. A substance with **pH of 7 is considered neutral.** Water usually has a pH of 7.0. A strong acid or alkali can lead to degradation of the container.

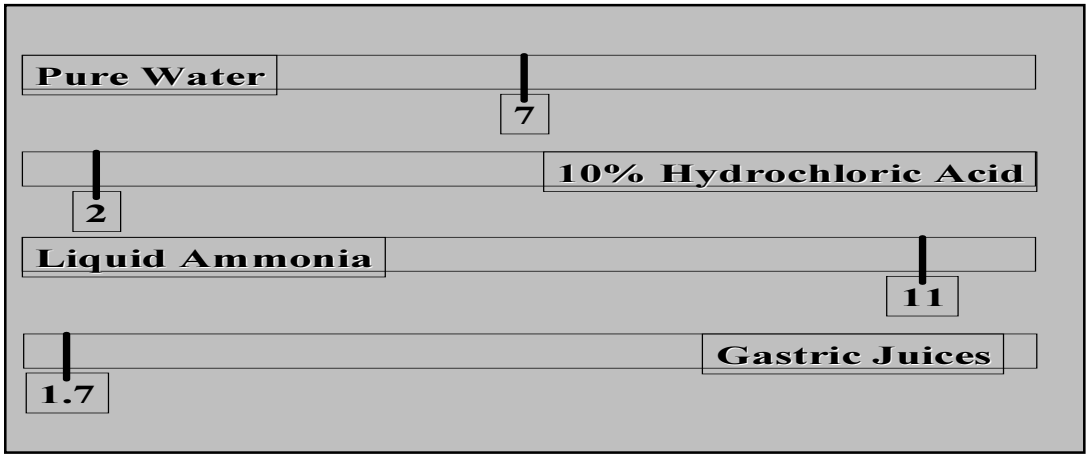


Figure 3.2 pH of some familiar materials

Lower Explosive Limit (LEL) – The lower explosive limit is the **lowest concentration of a substance in the air, expressed as a percentage, at which that substance will burn.** A substance will not burn if the concentration is below the LEL. The LEL varies from chemical to chemical.

Upper Explosive Limit (UEL) – The upper explosive limit is the **highest concentration of a substance in the air, also expressed as a percentage, at which that substance will burn.** A substance will not burn if the concentration is above the UEL. The UEL varies from chemical to chemical.

Flammable (explosive) range– The flammable range of a substance is the **difference between the lowest concentration (Lower Explosive Limit or LEL) and highest concentration (Upper Explosive Limit or UEL) at which a substance will burn**. Take note that a substance may still burn if it is classified as a non-flammable substance. The designation refers a legal

definition and not a chemical definition. If a substance has a flammable range, it will burn!!!! Figure 3.3 illustrate the flammable range of some popular chemicals.

Flash point – The flash point is a **temperature that vapors will burn in a flash when ignited by an outside source**, and then go out. This temperature is important because this will help you understand the relative degree of hazard that you face. Keep in mind that the flash point for a substance may be the ignition temperature for a different material.

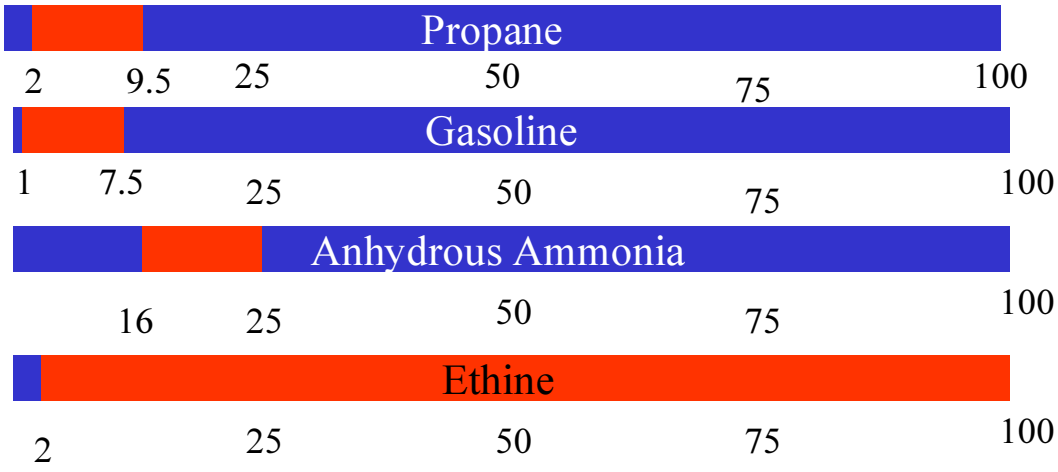


Figure 3.3 Flammable Ranges of common chemicals
The lighter area indicates the flammable range.

Ignition (autoignition) temperature – The ignition temperature of a substance **is the temperature at which a substance will ignite and continue to burn without being ignited from an outside source.** This is a concept similar to the flash point, and may referred to as the ignition point.

Melting Point – The melting point of a substance **is the temperature at which a substance changes from a solid into a liquid.** When ice is heated to 33° F, it becomes a liquid. Most substances will go from a solid to a liquid.

Physical State – During your training at the awareness level, you learned that there were three basic types of a substance, **solid, liquid or gas**. In chemistry, these are called physical states. Ice, water and steam are representative of a solid, liquid and gas respectively.

Radioactive Materials – As a hazardous materials first responder in Kentucky, you need to be aware of radioactive materials. Shipments of radioactive materials are not uncommon in Kentucky. Hospitals, industrial facilities and universities are just a few places that use radioactive materials. In addition, I-64 and I-75 are primary routes to and from the U.S. Department of Energy's Oak Ridge facility. I-24 and some of the parkways in Western Kentucky serve as major conduits for transportation to and from the Paducah Gaseous Diffusion Plant in McCracken County. Ionizing radiation is radiation that can produce charged particles, called ions, in any material it strikes. These ions can cause damage to cells and tissues, as well as modify the molecules of a substance. There are four types of ionizing radiation: alpha, beta, neutron, and gamma.

a) **Alpha particles** – these are the least penetrating of the four types of ionizing radiation. These particles cannot penetrate the skin and can be stopped by a piece of paper or clothing. These are **a health hazard only when they are swallowed, inhaled or enter the body through a wound**.

b) **Beta particles** – these can travel in the air several hundred times the distance of alpha particles. These particles **can penetrate the skin and tissues**. However, they may be blocked by several millimeters of aluminum.

c) **Neutron particles** – these particles are given off by the fission of some elements, such as Uranium-235. These elements are used in nuclear weapons and nuclear reactors. These do not have an electrical charge and can do severe damage to the body since they have a **great penetrating power.**

d) **Gamma Rays** – Gamma rays are **pure energy** and not particles. These are **very penetrating** and can travel many feet in the air and through tissues.

e) **Half-life** – half life is the period of time needed for half of a given amount of a material to change to another nuclear for or element. **It is a measure of the rate of decay of a radioactive material.**

Specific gravity – **Specific gravity is the relative weight of a solid or liquid when compared to the weight of an equal volume of water**. The specific gravity of water is 1.0. If a substance is has a higher specific gravity than 1.0 it is heavier than water, and it will sink. An example of this is yellow phosphorus (Sp. Gr. = 1.82.) If a substance has a specific gravity of lower than 1.0, such as gasoline (Sp. Gr. = .72) then it will float on water. Specific gravity will be important as containment efforts are considered.

Sublimation – **Sublimation is defined as the direct passage of a solid into a vapor**. It occurs when a solid skips the intermediary phase of becoming a liquid and goes directly into a vapor state. An example of this is carbon dioxide, which vaporizes at room temperature. The process may also be reversed under the right conditions of temperature.

This picture shows diesel fuel from a spill near Winchester (Clark County) The long things on the left side are booms used for stopping the spread of the fuel that is sitting on top of the water..

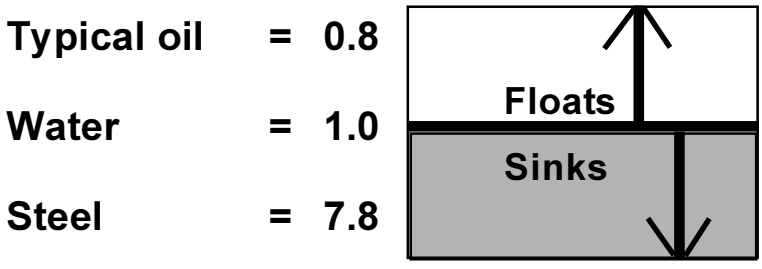


Figure 3.4 A representation of specific gravity.

Toxic products of combustion – When a substance burns, it is chemically changed and becomes a new substance or multiple new substances. Often times, these new substances are

toxic. **Any smoke or product produced by combustion should be considered toxic until it is proven otherwise**. If the carpet in your living room should burn it may produce ammonia and hydrogen cyanide both are hazardous materials and are fatal in small doses. When a car burns, it may produce phosgene gas, otherwise known as mustard gas, a chemical weapons used during WWI. However, the toxic products of combustion may be taken for granted. If you allow a car to run in a closed building, you know that this produces carbon monoxide, another toxic gas. The concern for a container is that some of the toxic products of combustion may also degrade the integrity of the container.

<u>Vapor density</u> – **Vapor density is the relative weight of gas when compared to air**. The weight of air is 1.0. If a the vapor density of a gas, such as chlorine (VD = 2.47) is greater than 1, the gas is heavier than air and tends to stay low, close to the ground. If the vapor density is less than 1.0 than the gas is lighter than air and will rise. An example of this is ammonia (VD = 0.60.) In the National institute of Occupational Safety and Health (NIOSH) Pocket Guide to Hazardous Materials, vapor density is referred to as Relative Gas Density (RGasD).

<u>Vapor pressure</u> – The vapor pressure is **the pressure exerted by a liquid's escaping vapors of the walls of a container.** The higher the vapor pressure, the faster a product will evaporate. If that product is a flammable liquid, then more vapors that are flammable are produced and have a greater chance of ignition. For example, water at about 75° F has a vapor pressure of 30 mmHg (millimeters of mercury) where gasoline may have a vapor pressure of nearly 300 mmHg. Therefore, gasoline will evaporate 10 times faster than water. The higher the vapor pressure, the higher the amount of stress placed on the walls of a container.

Chlorine has a high vapor denisity and will tend to hug the ground as in this picture. When approaching a hazardous materials scene, avoid driving or walking through clouds.

Water solubility – Water solubility the ability of a substance to dissolve in water. If a substance will completely dissolve in water, it is said to be miscible. If it will not dissolve in water at all, then it is said to be insoluble. If a substance partially dissolved in water, then it is called partially soluble. The more soluble a substance is, the more likely it is to contaminate a water source, and the more difficult it is to clean up.

Exposure – The process by which people, animals, the environment or property are subjected to or come in contact with a hazardous material. ***Exposure has everything to do with your safety.*** Exposure to a toxic material can end is permanent disability or even death. The magnitude of exposure is dependent upon the duration of the exposure and the concentration of the hazardous material.

Hazard – If exposure is an actual contact with a product that may cause injury or damage, then a **hazard is the potential for contact with anything, including a hazardous material, that can cause damage to health, the environment, or property.**

Contamination – **Contamination is a process of transferring a hazardous material from its source to people, animals, the environment, or equipment, which may act as a carrier**. In other words, getting the substance on you is considered contamination. *This differs from exposure because contamination does not necessarily mean that damage occurs*. Your clothing could be contaminated, however your health may not be damaged. Your cruiser or POV could be contaminated, but not necessarily damaged.

Decontamination is required when you become contaminated.

Secondary Contamination – **Secondary contamination is the process of people, animals, the environment, or property being contaminated out of the hot zone.** For example, a bystander walks through a pool of a hazardous substance. That is contamination. However, if this same bystander were to walk up to you and touch you, contaminating you with product as you lean against your car in the cold zone, you would have become contaminated through secondary contamination.

You have seen many definitions. Although some of these terms may not mean much now, they will as you progress through this course. However, understanding these terms is essential to predicting the behavior of a material and thus estimating the likely harm if you choose not to intervene with the release of a hazardous material.

CONTAINER BEHAVIOR

Introduction to Container Behavior

In the previous section of this course, you studied the containment systems used for hazardous materials at fixed facilities and during transportation. You learned how those containers are supposed to function in ideal conditions. In this section, you will learn how containers can fail and what the results of container failure might be.

Understanding how these containers fail and the results of container failure will help you more accurately estimate what will happen if you do not intervene.

Types of Container Stress

There are three types of container stress: thermal, mechanical and chemical. During an accidental release, whether it is a derailment, a traffic accident or an equipment failure at a fixed facility, a container can undergo one or all of these types of stress. The alert responder will be watching for these stresses and sensitive to the potential outcomes.

Thermal Stress

Thermal stress is caused not only by extreme heat, but also by extreme cold. When you learned about the rail cars, you learned that some rail cars have thermal protection on them to protect them from a torch or pool fire. You also learned that aluminum tanks have a tendency to melt in a hot fire, allowing the contents to be released. There are many ways that thermal stress can occur.

Fire
Electricity
Friction
Exposure to cryogenic materials

Mechanical Stress

Mechanical stress is common during an accident. It is a result of a transfer of energy when one object impacts another. Punctures, gouges, breaks, cracks or other tears in the container are characteristic of mechanical stress.

Chemical Stress

Chemical stress occurs when two or more chemicals have a chemical chain-reaction. Chemical stress is a little more insidious than the other stresses. In many cases, the chemical stress takes place from the inside out and is only recognized when the container fails. Chemical stress includes corrosive materials attacking a metal, pressure or heat from decomposition, pressure or heat from polymerization or any variety of corrosive actions.

Types of Container Failure

Rust is an example of chemical stress on a metal tank.

When a container fails (breaches), it will release its contents. There are five ways a container can fail: Disintegration, runaway cracking, failure of container attachments, container punctures or container splits or tears.

Disintegration

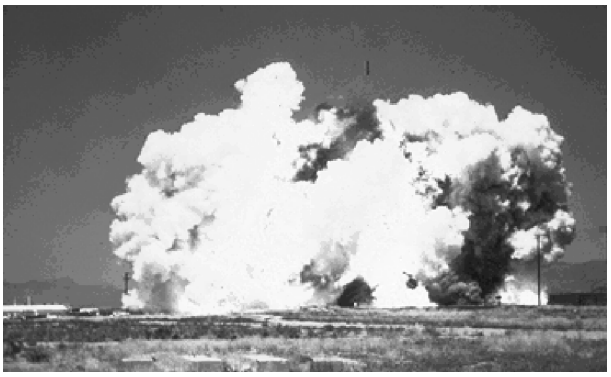
Disintegration is the total loss of container integrity. Although this is usually associated with explosives, disintegration may also be visualized as a carboy shattering.

Runaway Cracking

Runaway cracking occurs usually in closed containers such as pressure containers and drums. A small crack suddenly becomes a fast developing that circles the container. What results is a container being broken into two or more pieces. Many of the most famous catastrophic BLEVEs are associated with runaway cracking. If you have ever broken a tempered glass window, such as that in a car passenger window, you have an idea of runaway cracking.

Failure of Container Attachments

This is the most common container failure. Discharge valves fail and the fittings for attachments break allowing product to be released. The weakest point of any container is beside the weld. Most container attachments are welding in place. Other container attachments are meant to fail to prevent a more serious, violent container failure, such as frangible (rupture) disks and fusible plugs. Many times, packing nuts on valves are the cause of this. An example of this happened just before Thanksgiving 2000 in Winchester (Clark County), when several gallons of anhydrous ammonia were released.

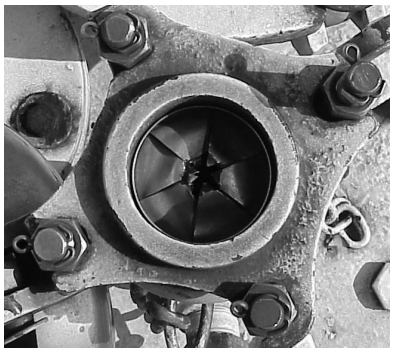


The picture of this BLEVE in Kingman, Arizona was taken several miles away. BLEVEs are the result of runaway cracking.

This is half of the tank that exploded in Kingman. Notice the results of thermal damage around the ends

Container Punctures

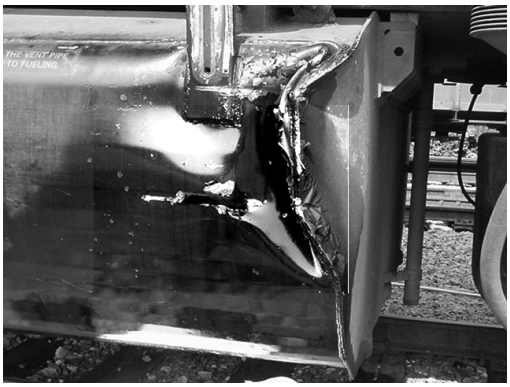
When a container is punctured, it usually results in a container failure. For example, in Muhlenburg County, a rod punctured a saddle tank on a locomotive causing several hundred gallons of diesel fuel to be spilled.



This is a picture of a ruptured frangible (rupture) disk in an acid car pressure relief device. Once this opens, there is a direct opening to product. This will allow acid to spill out over the car.

Container Splits or Tears

This is another common type of container failure. This occurs when bags or boxes are broken. However, this can also occur when seams on large tanks fail. As mentioned above, the



This saddle tank was punctured from debris left from a truck accident.

weakest metal of a tank is located next to the welds.

Types of Content Releases

When a container fails, the contents are free to escape in the form of energy (combustion), matter, or a combination of both. The speed at which the contents release is very important since it will determine your ability to control it. Also, the faster the release, the greater chance of harm.

There are four types of releases: detonation, violent rupture, rapid relief and spills or leaks. Imagine these with the tire on your car. A detonation occurs if it is packed with explosives. A violent rupture is a blow out at high speed. Rapid relief would be if someone stuck a knife in the tire or pulled the "T" stem out. In addition, a leak would be from a small nail

Detonation

A detonation is a chemical chain reaction with a release rate of less than 1/100th of a second. This release will give you no time to react. This type of release is associated with munitions, explosives and organic oxidizers.

EXPLOSION

Violent Rupture

A violent rupture is associated with runaway cracking and overpressure of closed containers (BLEVE). This occurs when chemical reactions occur with a rate of release of less than one (1) second. Again, this will not give you time to react.

Rapid Relief

This occurs in a time frame of several seconds to several minutes, depending on the size of the opening, the type of the container, and the type of material. This may give you adequate time to reach a safe place. Usually, this is associated with the failure of containers under pressure, relief valves opening, punctures, splits or broken piping.

VENTING

Leaks and Spills

Leaks and spills are probably the most familiar release type. These may occur over minutes or days. Generally, these are not violent and occur due to broken valves or small openings. These types of releases should provide you with the time needed to develop adequate countermeasures.

Types of Dispersion Patterns

Once a material is released, you need to be concern with the pattern it will follow. As a rule of thumb, the farther the substance travels from its container, the more problems you are going to encounter. The area contaminated by the material will depend on the type of the release, the nature of the substance, the chemical and physical laws of science, and the environment.

There are seven dispersion patterns. Hemisphere; cloud; plume; cone; stream; pool; and irregular.

Pressure Waves

Energy will disperse in the form of pressure waves. Pressure waves are invisible, but can pick up dust, fragments, shrapnel or chunks and propel them through the air. The best illustration of a pressure wave is the thump you feel in your chest as you hear a sonic boom.

Fragments, Shrapnel or Chunks

Solid materials will spread out in the form of fragments, shrapnel, or chunks. These are self-propelled resulting from an explosion or due to high heat.

Flowing Liquids

Liquids will take the path of least resistance. This means they will flow downhill. This is why you are instructed to approach a scene uphill of the spill or release. This pattern usually follows the lay of the land.

Vapor Dispersion

Vapors will disperse in the atmosphere and move down wind if they are lighter than air, (ammonia). If they are heavier than air, they will move down wind along the ground (chlorine), much like a liquid.

CHAPTER FIVE - HAZARD IDENTIFICATION

TERMINAL OBJECTIVES

1. When given a known hazardous materials emergency, you will be able to collect hazard and response information using material safety data sheets (MSDS), CHEMTREC/CANUTEC/ SETIQ, and contacts with the shipper/manufacturer.
2. When given a hazardous materials emergency, you will be able to collect hazard and response information using resources other than the ERG, MSDS, CHEMTREC and contacts with the shipper of manufacturer.

ENABLING OBJECTIVES

Hazard Classifications

1. Match the definitions associated with the DOT hazard classes and divisions of hazardous materials, including refrigerated liquefied gases and cryogenic liquids, with the class or division

MSDS

2. Identify two ways to obtain a material safety data sheet (MSDS) in an emergency.
3. Using a material safety data sheet (MSDS) for a specified material, identify the following hazard and response information:

   (a) Physical and chemical characteristics
   (b) Physical hazards of the material
   (c) Health hazards of the material
   (d) Signs and symptoms of exposure
   (e) Routes of entry
   (f) Permissible exposure limits
   (g) Responsible party contact
   (h) Precautions for safe handling (including hygiene practices, protective measures, procedures for cleanup of spills or leaks)
   (i) Applicable control measures including personal protective equipment
   (j) Emergency and first aid procedures

CHEMTREC

4. Identify the following:

   (a) Type of assistance provided by CHEMTREC/CANUTEC/SETIQ
   (b) Procedure for contacting CHEMTREC/CANUTEC/SETIQ
   (c) Information to be furnished to CHEMTREC/CANUTEC/SETIQ
5. Identify two methods of contacting the manufacturer or shipper to obtain hazard and response information.

Reference Materials

6. Give examples of ways to verify information obtained from the survey of a hazardous materials incident. Use at least two (2) reference materials other than MSDS, ERG, or shipping papers. These may include the following:

(a) Chemical Hazards Response Information System (CHRIS) Manual
(b) Emergency Handling of Hazardous Materials in Surface Transportation
(c) Fire Protection Guide on Hazardous Materials
(d) Farm Chemicals Handbook
(e) National Institute of Occupational Safety and Health (NIOSH) Pocket Guide

Introduction to Resources

As a hazardous materials first responder, you know that there is danger in responding to a hazardous materials incident. You also know there are numerous materials you can use to determine the hazards you are facing. You are still learning to evaluate what will happen should you choose not to intervene. Using the information you can gather from the tools discussed in this chapter will help you make an informed decision, hopefully with a view of the big picture.

You will find that some of the material in this chapter is a review of the material in the hazardous materials first responder awareness level. You will also notice that there is not a comprehensive review of the Emergency Response Guidebook (ERG.) The reason for this is that at the awareness level, you are expected to have a solid grasp on the use of the ERG. If you need a refresher, KyERC offers a 3 to 4 hour course that should increase your proficiency with the ERG.

You will get a brief overview of several different resources that will help you identify the hazards that the materials present. These materials are just a few of many available resources. In addition, this chapter does not take the place of practice or experience. Therefore, you must practice with these resources or the resources you will have with you at the scene.

Hazard Classifications

The U.S. Department of Transportation (DOT) has incorporated the United Nations Hazard Classification System. This system organizes substances by major hazards. However, it is important to note that some substances have multiple hazards. The designated primary hazard is clear to the responder, but secondary hazards may not be as clear. This is why you must use other resources to evaluate the hazards of a substance. Table 4.1 describes the nine (9) hazard classes and their divisions used by the DOT and examples of each.

Material Safety Data Sheets

At the awareness level, you learned that Material safety data sheets (MSDS) are required by OSHA's 29CFR 1910.1200, the Hazard Communications Standard. This standard requires every work site that handles, uses, processes or stores hazards materials of any type to have a MSDS available at the site for each hazardous material. This provides a bonus for you as an emergency responder because you can request to see the MSDS when you arrive at the scene.

Should you arrive on scene and the MSDS's are not available, you can request them from CHEMTREC or attempt to obtain the MSDS from the Internet. Several websites, including the Cornell University website have an extensive database of MSDS's. Finally, you can get the MSDS from the manufacturer.

The MSDS is an excellent source of specific information concerning a chemical at a fixed facility. MSDS will usually not be found during a transportation incident. Chemical manufacturers, importers and distributors are required to provide the MSDS when they deliver a chemical to a facility. The MSDS provides a great deal of valuable information for you as an emergency responder. Federal law requires any business that has a hazardous material on site to submit

copies of the MSDS to the fire department that provides fire protection to the business, to the local emergency planning committee and to the Kentucky Emergency Response Commission (KyERC). In lieu of a MSDS for the chemicals on site, a business may submit a list of chemicals requiring an MSDS.

Although certain information is required to be on a MSDS, there is not a set format for the information. The required information on a MSDS enables you to estimate the probable harm that the chemical could cause, potential hazard and risks that might arise in an emergency. The following is a list of information required on the MSDS.

- Product name and manufacturer (Responsible party contact)
- Physical and chemical characteristics
- Fire or explosion (physical) hazards of the material
- Health hazards of the material
- Signs and symptoms of exposure
- Routes of entry
- Permissible exposure limits
- Precautions for safe handling (including hygiene practices, protective measures, procedures for cleanup of spills or leaks)
- Applicable control measures including personal protective equipment
- Emergency and first aid procedures

In the pages that follow, you will find three MSDS of different formats. Becoming familiar with the MSDS is as important as becoming familiar with the ERG.

DOT'S HAZARD CLASSES AND DIVISIONS				
CLASS	DIV	EXPLANATION OF CLASS/DIVISION	EXAMPLES OF MATERIALS	GENERAL HAZARDS (NOT ALL INCLUSIVE)
1	EXPLOSIVES			
	1.1	**Explosive with mass explosion hazard.**	Dynamite and TNT	Explosive. Exposure to heat, shock or contamination could result in thermal and mechanical hazards
	1.2	**Explosives with a projection hazard**, but not a mass explosion hazard.	Projectiles with bursting charges; hand grenades	
	1.3	**Explosives with a fire hazard** and a minor blast hazard or projection hazard or both; but not a mass explosion hazard.	Rocket motors, propellant explosives, special fireworks	
	1.4	**Explosives that present a minor explosion hazard** – no projectiles	Common fireworks; ammunition	
	1.5	**Very insensitive explosives** – mass explosion hazard	Ammonium nitrate – fuel oil mixtures (ANFO)	
	1.6	**Extremely insensitive explosives** – no mass detonation hazard		
2	Gases			
	2.1	**Flammable Gas** – any gas which has a pressure of less than 14.7 psi and ignites at a concentration of at least 12% with air.	Propane, butane, acetylene	Under pressure; container may fail with or without fire; may be flammable, toxic, corrosive, an asphyxiant, and/or thermally unstable.
	2.2	**Non-flammable, non toxic, or compressed gasses**	Carbon dioxide, anhydrous ammonia	
	2.3	**Toxic Gases**	Phosgene, chlorine, methyl bromide	
3	FLAMMABLE OR COMBUSTIBLE LIQUIDS			
		Flammable Liquid – any liquid with a flash point of 141° F or below; or any substance in a liquid form with a flash point of 100°F or above and is transported at or above its flash point.	Gasoline, methyl alcohol, acetone	Flammable; container may fail due to heat or fire; may be corrosive, toxic and/or thermally unstable
		Combustible liquids similar to flammable liquids, but have a flash point above 141° F and below 200 F.	Fuel Oils	
4	FLAMMABLE SOLIDS			
	4.1	**Flammable Solids** – desensitized explosives; self reactive materials; and readily combustible solids	Matches	Could cause thermal burns.
	4.2	**Spontaneously Combustible Materials** – pyrophoric materials and self-heating materials	Phosphorus, charcoal briquettes	

Table 4.1

DOT'S HAZARD CLASSES AND DIVISIONS (CONTINUED)				
CLASS	DIV	EXPLANATION OF CLASS/DIVISION	EXAMPLES OF MATERIALS	GENERAL HAZARDS (NOT ALL INCLUSIVE)
	4.3	**Dangerous when Wet Materials** – a material that, by contact with water, is liable to become spontaneously flammable or give off flammable or toxic gas.	Calcium carbide, potassium	
5	**OXIDIZERS AND ORGANIC PEROXIDES**			
	5.1	**Oxidizers –** A material that may cause or enhance the combustion of others, by releasing oxygen.	Ammonium Nitrate, oxygen	Sensitive to heat, shock, friction, and/or contamination
	5.2	**Organic Peroxide**	Bezoyl peroxide	
6	**TOXIC MATERIALS AND INFECTIONS SUBSTANCES**			
	6.1	**Toxic Materials –** a material other than a gas, that is known to be so toxic to humans as to afford a health hazard.	Carbon tetrachloride	Toxic by inhalation, ingestion, and skin and eye contact; may be flammable
	6.2	**Infectious Substances** – a substance that causes disease in humans or animals	Anthrax, botulism	
7	**RADIOACTIVE MATERIALS**			
		Radioactive materials	Cobalt, uranium hexafluoride	May cause burns and biologic effects; may be in the form of energy
8	**CORROSIVE MATERIALS**			
		Corrosive Materials – a liquid or solid that causes full thickness destruction of human skin or a liquid that can cause the destruction of aluminum or steel.	Sulfuric acid, mercury,	Takes place at the site of contact; may be fuming or water reactive
9	**MISCELLANEOUS MATERIALS**			
		Miscellaneous Hazardous Materials – a material that presents a hazard during transportation but does not meet any other hazard class definition	PCB's, dry ice	Could cause annoyance or discomfort; hazardous waste
ORM-D		**Other Regulated Materials –** consumer commodities that present a hazard during transportation due to its form, packaging, or quantity	Consumer commodities – batteries, HTH	Class is misleading; could have any of the above hazards

SULFURIC ACID, FUMING MSDS
UN/ID NUMBER 1831

ETHINE MSDS

UN/ID NUMBER 1001

PHOSPHINE MSDS
UN/ID NUMBER 2199

□□□

CHEMICAL TRANSPORTATION EMERGENCY CENTER (CHEMTREC) (800) 424-9300

CHEMTREC is a public service of the Chemical Manufacturer's Association that operates out of Washington, D.C. The Canadian counterpart of CHEMTREC is called CANUTEC. The Mexican counterpart is called SETIQ. You can find the numbers for all of these agencies located in the back cover of the ERG.

CHEMTREC is a valuable resource for the on-scene incident commander during a chemical emergency. They provide 24-hour information by telephone and fax with data available on over 350,000 chemicals. CHEMTREC has the ability to teleconference on-scene personnel with other agencies or groups that can provide assistance for the incident.

They have the ability to contact the shipper or manufacturer of the hazardous materials involved. The manufacturer and/or the shipper can provide detailed information concerning the particular chemical. CHEMTREC will also notify the National Response Center (NRC), operated by the United States Coast Guard, and if necessary, can patch you directly to the NRC.

As mentioned above, CHEMTREC operates 24-hours a day, 365 days a year. To contact CHEMTREC, call (800) 424-9300. Although they can provide you with hazard information, warnings and guidance from the four digit ID number or the name of the product, they can provide a greater amount of specific information if you provide them with specific information when you call. It is best to assemble the information before calling. Below is a list of information to give to CHEMTREC.

Your name, call back number, and FAX number
Location and nature of the problem
Name and identification number of the material(s) involved
Shipper/consignee/point of origin
Carrier name, railcar or truck number
Container type and size
Quantity of material transported/released
Local conditions (weather, terrain, and proximity to schools/hospitals)
Injures and exposures
Local emergency services that have been notified.

Only call CHEMTREC's 800-telephone number during an emergency. Should you need to call to obtain non-emergency information or contact the manufacturer you may use telephone number is (202) 887-1255. CHEMTREC is an important resource and should be used.

Reference Materials

In 2000, 34 Emergency Planning Committees received libraries to help them better do emergency response planning. These libraries consisted of many of the reference materials discussed in this section. The reasoning for this is simple, in order to plan a response, you have to understand what information will guide the response. This is why the KyERC and local emergency planning committees chose these publications.

It is very important that you use no less than three resources for any one hazardous materials incident. It is just as important that you read thoroughly whatever resources are available to you. Finally, practicing with these resources helps you become familiar with the strengths and weaknesses of each one.

Emergency Handling of Hazardous Materials is Surface Transportation

Hazardous Materials Systems, Association of American Railroads
50 F Street, NW
Washington, D.C. 20001
(202) 639-2222/To order call (412) 741-1096 and ask for customer service

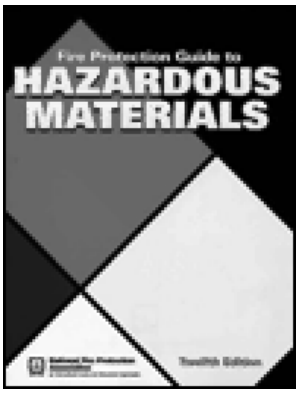
This book is divided into two sections. Section I covers general information on approaching the hazardous materials incident, materials identification information, responding to accidents in tunnels, general emergency response information for each DOT hazard class and explanation of the terms in the book.

Section II consists of commodity specific emergency response information for each hazardous material regulated by the DOT in table 172.101 of 49 CFR. Also included are many of the materials that are shipped under one of the many “n.o.s.” descriptions such as flammable liquid, n.o.s. Each material that may use this “n.o.s.” type of listing is listed by their technical name which appears on the shipping paper required by the US and Canada. In addition, emergency environmental damage mitigation is also presented for the EPA designated Hazardous Substances.

There are three (3) appendices. The first lists DOT required four (4) digit id numbers, the materials, and the pages to which those numbers apply. The second index lists the seven (7) digit HazMat Code (formerly known as the Standard Transportation Commodity Code STCC) assigned to the material’s hazard class.

The third index lists in numerical sequence all seven (7) digit HazMat Codes, the description of the commodity assigned tot hat code, and the page number where information on that commodity appears.

This is one of the standard texts used by emergency response personnel.



FIRE PROTECTION GUIDE TO HAZARDOUS MATERIALS

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269
To order call (800) 344-3555

This text is designed to help emergency responders from all services that handle hazardous materials. There are four sections to this book. The first lists the data on the health, fire and reactivity hazards of 325 chemicals. This listing includes recommendations on storage and firefighting. The NFPA 704 numbers are shown for all entries. Chemicals are arranged alphabetically by the DOT common shipping name. Common names are listed by a cross-reference index at the end of the document. In addition, a Chemical Abstract Service (CAS) number index has been added.

The second section lists in alphabetical order the fire hazard properties of more than 1,300 flammable substances by chemical name. The values selected are representative figures suitable for general use. In addition, the NFPA 704 numbers are included for most entries.

The third section is a list of 3,600 mixtures of two or more chemicals reported to be potentially dangerous because they may cause fires, explosions or detonations at ordinary or moderately elevated temperatures. The reactions are referenced and the chemicals are arranged alphabetically by chemical name.

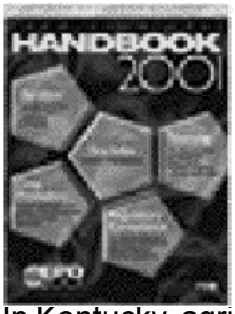
The fourth section explains the NFPA 704 hazard identification system. Included are the special symbols you will find in the white diamond on the bottom of the 704 symbol.

U.S. COAST GUARD

CHEMICAL HAZARD RESPONSE INFORMATION SYSTEM (C.H.R.I.S.) MANUAL

U.S. Government Printing Office
Washington, D.C. 20402
To order call (212) 512-0000 – Stock number 050-012-00215-1

This system was developed by the United States Coast Guard, however it is not just for incidents involving waterways or watersheds. It consists of four manuals, the second manual is known as the Hazardous Chemical Data Manual. The manual presents detailed information on nearly 1,000 chemicals, presented in a one-chemical-per-page format.



FARM CHEMICALS HANDBOOK

Meister publishing Company
37733 Euclid Ave
Willoughby, OH 44094
To order call (800) 572-7740 or email fchb_circ@meisterpubl.com

In Kentucky, agriculture is a major industry. Farm chemicals are present in most communities throughout the state. The Farm Chemicals Handbook is an invaluable resource for referencing

toxicity, names, addresses and telephone numbers of the manufacturers for additional information. This book provides descriptions of crop chemicals that include toxicity class, solubility, flash point handling and storage cautions, etc. This is the only available index listing fertilizer and pesticide products, cross-referenced by both trade name and common name.

The First Responder's Pocket Guide to Hazardous Materials Emergency Response

Firebelle Productions
P.O. Box 110848
Campbell, CA 95011-0848
To order call (800) 477-7151

This is a quick reference for you. It provides pictures of labels and placards, general response information, and resource information. It is a good resource to carry with your response gear or in a brief case.

Emergency Care for Hazardous Materials Exposure

Mosby Lifeline
11830 Westline Industrial Drive
St. Louis, MO 63146

This book has six sections geared toward the medical response to a hazardous materials response. The first section is a chemical index, divided into three sections. The first is by DOT hazard class; the second is sorted by UN/ID number; and the third sorted by the chemical name in alphabetical order.

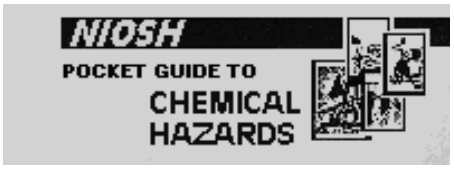
Section 2 includes 109 guidelines for general classes of materials. The guidelines include the following: Substance identification, routes of exposure, target organs, life threat, signs and symptoms by system, basic and advanced treatment and much more.

Section 3 is a series of treatment protocols. These give detailed information on therapeutic interventions as listed in the guidelines. These protocols are not meant to supersede local protocols but to be used in conjunction with them.

Section 4 is a listing of drug protocols.

Section 5 is operating procedures for EMS/Hazardous Materials Response Personnel. These are procedures for safe response practices, scene operations, and hazmat team support.

Section 6 is a listing of references used to compile the book. These will provide you with further guidance in doing developing protocols at the local level.



National Institute of Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards

Hazardous materials technicians are very familiar with this resource. However, it is a great resource for operations level responders. This is a spiral bound book presents key information and data in abbreviated tabular form for 677 chemicals or substance groupings (e.g., manganese compounds, tellurium compounds, inorganic tin compounds, etc.). Chemical Name and Structure/Formula, CAS and RTECS Numbers, and DOT ID and Guide Numbers. Each chart has some or all of the following:

Chemical Name and Structure/Formula - The chemical name found in the OSHA General Industry Air Contaminants Standard (29 CFR 1910.1000) is listed first. The chemical formula is

also provided under the chemical name.

CAS and RTECS Numbers - The Chemical Abstracts Service (CAS) number is unique for each chemical and allows efficient searching on computerized databases. The *NIOSH Registry of Toxic Effects of Chemical Substances* (RTECS) number may be useful for obtaining additional toxicologic information on a specific substance.

DOT ID and GUIDE Number - The U.S. Department of Transportation (DOT) identification number and the corresponding guide number. Their format is xxxx xxx. The Identification number (xxxx) indicates that the chemical is regulated by DOT. The Guide number (xxx) refers to actions to be taken to stabilize an emergency; this information can be found in the 2000 Emergency Response Guidebook. A page index for all DOT ID numbers listed is included at the back of the *Pocket Guide* to help the user locate a specific substance; please note however, that many DOT numbers are NOT unique for specific substances.

Synonyms, Trade Names, and Conversion Factors - Common synonyms and trade names are listed alphabetically for each chemical. Factors for the conversion of ppm (parts of vapor or gas per million parts of contaminated air by volume) to mg/m^3 (milligrams of vapor or gas per cubic meter of contaminated air) at 25 °C and 1 atmosphere are listed for chemicals with exposure limits expressed in ppm.

Exposure Limits - The NIOSH recommended exposure limits (RELs) are listed first in this column. The OSHA permissible exposure limits (PELs) are currently enforced by OSHA and are listed next.

Immediately Dangerous to Life and Health (IDLH) - The current NIOSH definition for an IDLH exposure condition is a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." The purpose of establishing an IDLH exposure concentration is to "ensure that the worker can escape from a given contaminated environment in the event of failure of the respiratory protection equipment." IDLH values are listed for over 380 substances. The notation "Ca" appears in this column for all substances that NIOSH considers to be potential occupational carcinogens. "10%LEL" indicates that the IDLH was based on 10% of the lower explosive limit for safety considerations even though the relevant toxicological data indicated that irreversible health effects or impairment of escape existed only at higher concentrations. "N.D." indicates that an IDLH has not as yet been determined.

Physical Description - This entry provides a brief description of the appearance and odor of each substance. Notations are made as to whether a substance can be shipped as a liquefied compressed gas or whether it has major use as a pesticide.

Chemical and Physical Properties - The following abbreviations are used for the chemical and physical properties given for each substance. "NA" indicates that a property is not applicable, and a question mark (?) indicates that it is unknown.

MW Molecular weight

BP Boiling point at 1 atmosphere, °F

Sol Solubility in water at 68 °F (unless a different temperature is noted), % by weight (i.e., g/100 ml)

Fl.P Flash point (i.e., the temperature at which the liquid phase gives off enough vapor to

flash when exposed to an external ignition source), closed cup (unless annotated "(oc)" for open cup), °F

IP Ionization potential, eV (electron volts) [Ionization potentials are given as a guideline for the selection of photoionization detector lamps used in some direct-reading instruments.]

VP Vapor pressure at 68 °F (unless a different temperature is noted), mm Hg; "approx" indicates approximately

MLT Melting point for solids, °F

FRZ Freezing point for liquids and gases, °F

UEL Upper explosive (flammable) limit in air, % by volume (at room temperature unless otherwise noted)

LEL Lower explosive (flammable) limit in air, % by volume (at room temperature unless otherwise noted)

MEC Minimum explosive concentration, g/m^3 (when available)

Sp.Gr Specific gravity at 68 °F (unless a different temperature is noted) referenced to water at 39.2 °F (4 °C)

RGasD Relative density of gases referenced to air = 1 (indicates how many times a gas is heavier than air at the same temperature)

Incompatibilities and Reactivities - This entry lists important hazardous incompatibilities or reactivities of each substance.

Measurement Method - This entry provides a brief, key word description of the suggested sampling and analysis method. Each description comprises four components: (1) the collection method, (2) the sample work-up, (3) the analytical method, and (4) the method number. The method number is usually from the 4th edition of the NIOSH Manual of Analytical Methods (DHHS [NIOSH] Publication No. 94-113) and is indicated by "IV" following the sample work-up. If a different edition of the *NIOSH Manual of Analytical Methods* is cited, the appropriate edition (and, for the 2nd edition only, the volume number) would be noted [e.g., II(4)]. In a number of instances, the table cites the *OSHA Analytical Methods Manual* (or the OSHA web site, http://www.osha-slc.gov/dts/sltc/methods/) and applicable method number (e.g., OSHA [#21]). When a method for a particular substance is not included in the latest NIOSH or OSHA analytical methods manuals or at the OSHA web site, "None available" is listed.

Personal Protection and Sanitation - This column presents a summary of recommended practices for each toxic substance. These recommendations supplement general work practices (e.g., no eating, drinking, or smoking where chemicals are used). Table 3 explains the codes used. Each category is described as follows:

SKIN: Recommends the need for personal protective clothing.

EYES: Recommends the need for eye protection.

WASH SKIN: Recommends when workers should wash the spilled chemical from the body in addition to normal washing (e.g., before eating).

REMOVE: Advises workers when to remove clothing that has accidentally become wet or significantly contaminated.

CHANGE: Recommends whether the routine changing of clothing is needed.

PROVIDE: Recommends the need for eyewash fountains and/or quick drench facilities.

First Aid - This entry lists emergency procedures for eye and skin contact, inhalation, and ingestion of the toxic substance.

Route of Health Hazard - This entry lists the toxicologically important routes of entry for each substance and whether contact with the skin or eyes is potentially hazardous.

Symptoms - This entry lists the potential symptoms of exposure.

Target Organs - This entry lists the organs that are affected by exposure to each substance.

This reference is very helpful on the scene. However, NIOSH has chosen to discontinue printing the NPG. It is available on CD-ROM or on the Internet at http://www.cdc.gov/niosh/.

SAMPLE OF A NIOSH POCKET GUIDE ENTRY

Chlorine

CAS 7782-50-5
Cl_2
RTECS FO2100000

Synonyms & Trade Names
Molecular chlorine
1017 124

DOT ID & Guide

Exposure Limits

NIOSH REL: C 0.5 ppm (1.45 mg/m^3) [15-minute]

OSHA PEL†: C 1 ppm (3 mg/m^3)

IDLH 10 ppm See: 7782505

Conversion 1 ppm = 2.90 mg/m^3

Physical Description
Greenish-yellow gas with a pungent, irritating odor. [Note: Shipped as a liquefied compressed gas.]

MW: 70.9	BP: -29°F	FRZ: -150°F	Sol: 0.7%
VP: 6.8 atm	IP: 11.48 eV	RGasD: 2.47	
Fl.P: NA	UEL: NA	LEL: NA	

Nonflammable Gas, but a strong oxidizer.

Incompatibilities & Reactivities
Reacts explosively or forms explosive compounds with many common substances such as acetylene, ether, turpentine, ammonia, fuel gas, hydrogen & finely divided metals.

Measurement Method
Filter; $Na_2S_2O_3$; Ion chromatography; IV [#6011] See: NMAM INDEX

Personal Protection & Sanitation

Skin: Frostbite	Eyes: Frostbite	Wash skin: N.R.
Remove: N.R.	Change: N.R.	Provide: Frostbite

First Aid (See procedures)
Eye: Frostbite
Skin: Frostbite Breathing: Respiratory support

Respirator Recommendations NIOSH
Up to 5 ppm: (APF = 10) Any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern*/(APF = 10) Any supplied-air respirator*
Up to 10 ppm: (APF = 25) Any supplied-air respirator operated in a continuous-flow mode*/(APF = 25) Any powered, air-purifying respirator with cartridge(s) providing protection against the compound of concern*/(APF = 50) Any chemical cartridge respirator with a full facepiece and cartridge(s) providing protection against the compound of concern/(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/(APF = 50) Any self-contained

breathing apparatus with a full facepiece/(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin and/or eye contact

Symptoms Burning of eyes, nose, mouth; lacrimation (discharge of tears), rhinorrhea (discharge of thin nasal mucous); cough, choking, substernal (occurring beneath the sternum) pain; nausea, vomiting; headache, dizziness; syncope; pulmonary edema; pneumonia; hypoxemia (reduced oxygen in the blood); dermatitis; liquid: frostbite

Target Organs Eyes, skin, respiratory system

See also: INTRODUCTION See ICSC CARD: 0126 See MEDICAL TESTS: 0044

Computer Based Resources

As computers and cellular communications become increasingly available, response teams need to invest in computers and cellular Internet connections. Many different reference materials are currently available on the internet or through computer connections. In addition, CAMEO (Computer Aided Management of Emergency Operations) is a sophisticated, well-known database that is actually a collection of 22 integrated programs and databases for personnel who are dealing with hazardous materials. The KyERC sponsors training on CAMEO.

In addition to these, your dispatcher or control can access information for you and fax it or email it to you on scene. The National Sheriff's Association "Hazardous Materials Information System," is an example of this.

CHAPTER SIX – ESTIMATING THE POTENTIAL HARM

TERMINAL OBJECTIVE

ENABLING OBJECTIVES

1. Identify the health and physical hazards that could cause harm.
2. Identify the health hazards associated with the following terms:
   Asphyxiant
   Chronic health hazard
   Convulsant
   Irritant/corrosive
   Sensitizer/allergen
3. Identify the three general time frames for predicting the length of time that exposures can be in contact with hazardous materials in an endangered area.
4. Identify and list the surrounding conditions that should be noted by the first responders when surveying hazardous materials incidents.
5. Identify a resource for determining the size of an endangered area of a hazardous materials incident.
6. Given the dimensions of the endangered area and the surrounding conditions at a hazardous materials incident, estimate the number and type of exposures within that endangered area.
7. Identify resources available for determining the concentrations of a released hazardous material within an endangered area.
8. Given the concentrations of the released material, identify the factors for determining the extent of physical, health, and safety hazards within the endangered area of a hazardous materials incident.
9. Describe the objectives and dangers of search and rescue missions at hazardous materials incidents.
10. Interpret the hazard and response information obtained from the current edition of the Emergency Response Guidebook, MSDS, CHEMTREC and shipper/ manufacturer contacts.
11. Interpret the hazard and response information obtained from the current edition of the Emergency Response Guidebook, material safety data sheets (MSDS), CHEMTREC, and shipper/manufacturer contacts

INTRODUCTION

You are beginning to move into the next phase of the response, choosing your response objectives. However, before you can choose your response objectives, you must have a full understanding of the incident. You need to know how the hazardous material can injure you, or do damage to the environment or property.

You have learned thus far what hazardous materials are, how to detect if they are present, and how to determine the hazard they present. The final step before you can start planning how to respond is taking the information you have gathered and process it into something that can meaningfully improve the safety, effectiveness and efficiency of your response. To do this you

must consider several things. You need to determine the dimensions of the endangered area and estimate the number of exposures within that area. You also have to determine the amount of the product in the endangered area by either measuring it or estimating the concentration. You will have to assess the physical, health, and safety hazards in the area so that you can identify locations of potential harm and assess the potential outcomes within that area.

Now it is time to take this information and apply it so that you can see the "big picture," and begin to form your response plan. In this chapter, you will learn about mapping the scene based on the information you have gathered from your observations and size up and the resources you have used.

At the end of this section, you will be given a few scenarios to allow you to apply what you have learned. The bottom line is, if you cannot properly assess the scene, you cannot move further into tactical operations. This is the line of demarcation from scene assessment to operational activities.

Physiological Effects of a Chemical Exposure

As a hazardous materials first responder at the awareness level, you learned about how a hazardous material can cause harm to your health. Whether it is a corrosive gas or flammable liquid, you learned how it could cause harm to you. The chart on the **opposite page is a refresher to help you identify the hazards**. In the section that follows, you will learn about the physiological effects of a chemical exposure.

Time Frames for Exposure

There are three (3) general time frames for predicting the length of time that an exposure can be in contact with hazardous materials in an endangered area. If an exposure is limited to minutes or a few hours, then it is considered short-term. If an exposure lasts days, weeks, or months, then the exposure is medium-term. A long-term exposure is years or generations. An example of the short-term exposure would be like the anhydrous ammonia leak that happened in Clark County in November 2000. The incident lasted only a few hours and terminated quickly and safely.

A medium term incident was like the sodium hexaflouride spill near the Madison-Rockcastle county line or the Danville Boxcar fire that lasted several days.

A long-term exposure would be like the Martin County Slurry Impoundment or the Maxey Flats area in Fleming County. Remediation of these areas will take several years, if not decades to complete.

Acute and Chronic Effects of Exposure

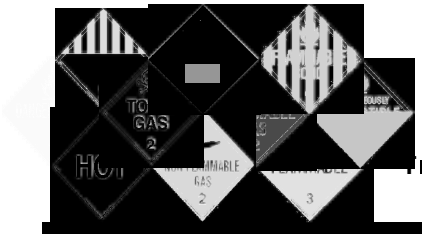
There are two types of exposure effects: acute, meaning it occurs immediately or it may be delayed days or weeks after an exposure. The effects may be chronic, meaning that they occur years and decades after exposure. It is very important to note that a chemical can have both acute and chronic effects.

Acute

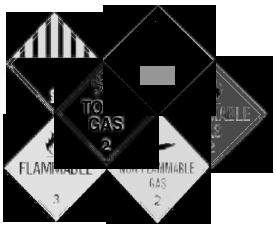
Immediate effects are acute in nature. Dizziness, nausea and vomiting, burns, respiratory difficulties, and central nervous system attacks are examples of acute effects.

Delayed effects are more insidious. Pulmonary edema (chemical pneumonia) is an example of the delayed effect. Pulmonary edema can occur within 48 hours of exposure or may not set in for several days.

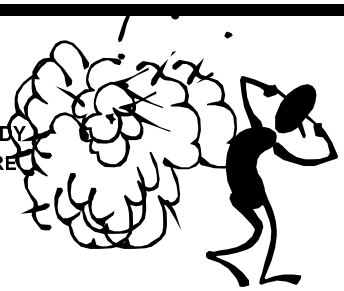
Hazards and Classifications

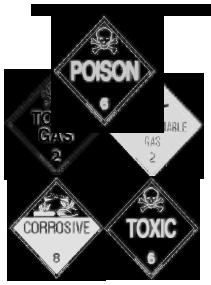


THERMAL – EXPOSURE TO HEAT OR COLD



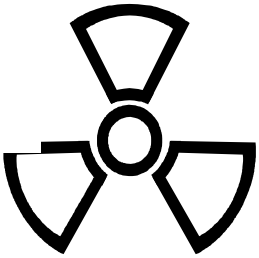
MECHANICAL – CAUSED BY THE BODY BEING HIT BY DEBRIS OR A PRESSURE WAVE



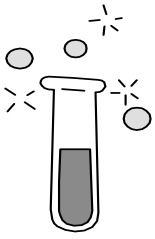


CORROSIVES – CAUSED BY BODY TISSUES BEING DAMAGED.
POSIONS/TOXINS – SYSTEMIC REACTIONS TO A SUBSTANCE.
ASPHYXIATION – OXYGEN IS DISPLACED OR ABSORBED SO THE BODY HAS LITTLE OR NONE TO PROCESS.

RADIATION – burns and internal damage caused by exposure to radioactive materials.



ETIOLOGIC – CAUSED BY MICROORGANISMS OR TOXINS PRODUCED BY MICROORGANISMS THAT CAUSE DISEASE IN HUMANS.



Chronic

Chronic effects of exposure are always delayed between time of initial exposure and the onset of problems. Black Lung Disease is an example of this. It has no acute effects, allowing the person to be exposed for several years without any ill effects. However, years after the exposure, the person may develop lung cancer or cancer of the lining of the lung. Chemicals that cause cancer are known as carcinogens. Many hazardous materials are known carcinogens.

As discussed in the awareness level course, there are four (4) routes of entry a chemical can enter the body: absorption, ingestion, inhalation and injection. This is also how you can be exposed to a hazardous material; you can breathe it. You may eat it. You might have it soak through your skin, or may be it is injected into you through a needle stick.

If you were to breathe in a chemical, you may experience one or many different inhalation injuries. Your respiratory tract may be irritated. You may suffer from chemical asphyxiation or have an allergic reaction. These reactions often mimic the signs and symptoms of common ailments. You must be acutely aware of their presence and what they may indicate.

Irritation

Irritation is a common local effect on the nose, throat, mouth, stomach or lungs. Chlorine gas, ammonia and phenols are good examples of irritants. You may experience discomfort, coughing, chest pain, cramps, nausea and vomiting, bleeding from the mouth and nose, and serious lung damage.

Chemical Asphyxiation

These chemical asphyxiants compete with oxygen at the level of gas exchange in the lungs and sometimes in the blood. You will probably recognize carbon monoxide as the best example of this class. Other examples are usually gases such as helium, methane, nitrogen, and other hydrocarbon gases

Systemic Problems

Some chemicals enter the blood when inhaled and circulate to “target” organs. These chemicals can cause serious damage to these organs. These organs are usually the kidneys or the liver. Organophosphate pesticides, solvents, lead and some components of gasoline are examples of chemicals that can cause these effects.

In addition to these effects, the negative effects of some chemicals may increase upon repeated or chronic exposures. Carbon monoxide (CO) is an example of this. One you have experienced CO poisoning, exposure to much lower concentrations can cause pronounced signs and symptoms of poisoning.

Effects with Nervous System Involvement

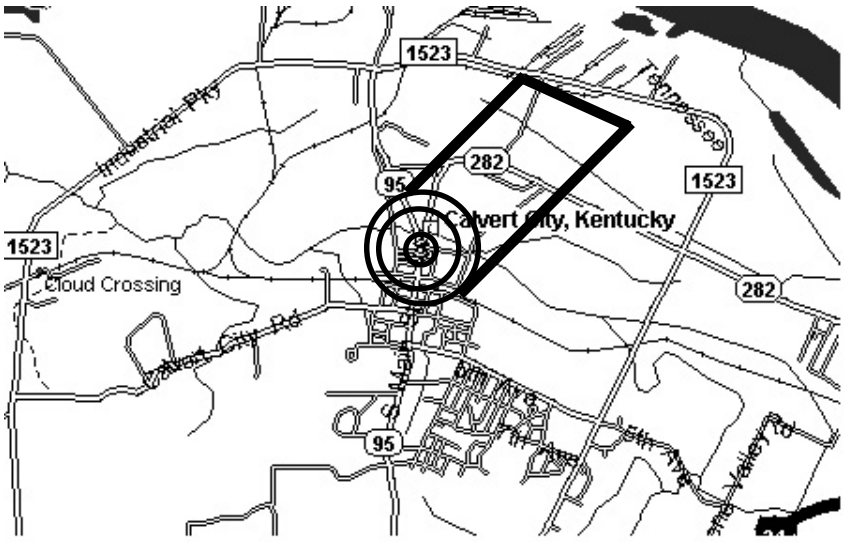
Some types of hazardous materials attack the nervous system. Awareness of the nervous system reactions may serve as indicators of exposure. You may witness or experience profuse sweating, headache or thirst when the nervous system is involved. In addition, you may have constricted pupil, disorientation, and a decline on mental status. Other effects may be convulsions, unconsciousness and death.

SURROUNDING CONDITIONS

Size up is an important part of any emergency response. You have to be alert to all the variables that can increase the hazard posed by the released. This is why site mapping is vital to safe, effective and efficient operations. Site mapping provides several advantages. It allows you the ability to plan future activities. It gives you a visual understanding of the scene layout. You can clearly identify access points into the high hazard areas. It allows you the ability to track personnel and assign control zones. Finally, it gives you the ability to determine the best placement of staging areas, the command post, and other incident facilities.

Your site map should contain several items. Obviously, you need to put the location of the hazard. However, it is also very helpful to draw out the accident (if there is one). In the case of an incident that occurs over a larger distance, it is essential to draw the scene by referencing North. Especially in the case of a train derailment, it is possible to become disoriented. It is important to use the railcar identification numbers to reference the car, since some cars may appear on one side of the crash, but not on another.

On your site map, you should draw drainage routes. If there is a possibility of a fire, or if you are dealing with a liquid or heavy gas, you must be concerned with where the fluid or gas may go. Street drains, sanitary sewers, ducts, and drainage ditches are important items to note on a site map.



The topography, or lay of the land, is also important. You need to be able to identify low areas, which might be an area for pooling of the hazardous material.

Draw out obstacles or exposures. These are helpful to responders who may be entering the scene in personal protective equipment that restricts visibility and movement and agility.

Mark the prevailing wind direction. This will quickly illustrate potential exposures and areas that you may have to evacuate or prescribe protective actions.

Note the location of creeks, ponds, streams, and all other related environmental concerns to fish, wildlife, and agriculture. These are important because you may have to take protective actions to prevent the hazardous material from affecting the fish and animals downstream.

Make a note of the type of neighborhood. Is it a rural, suburban, or inner city neighborhood? In addition, make notes of the population type and density. If the people living down the street are elderly or disabled, they may need assistance in taking protective actions, let alone evacuation.

Draw the location of the utilities, both overhead and underground. These are important because

they may add fuel, be the source of a leak, or create problems in other respects.

Even if the incident takes place inside a building, it is important to map the area. Building drains, stairwells, and elevator shafts can cause as many problems as a downhill grade or stream.

Now that you have put all of these items on your site map, you have a very busy picture. However, who is supposed to draw it? Moreover, once the map is drawn, who keeps it current? Upon arrival on the scene the map should be started. Throughout the emergency, as something changes, the map should be updated. The incident manager will often appoint someone to draw the map and keep it current.

Be certain to update that map as the incident progresses. Changes in site activities, accidents, newly discovered hazards, vandalism, and new work procedures should all be noted on the site map. Bear in mind that the site map is a legal document and it should be treated as such. Keep it neat and legible.

Determining the Endangered Area

Most people are happy when their work has been done for them. In this case, you are going to be happy because a dedicated group of people has already determined what areas are endangered for fixed facilities. In Kentucky, there are 118 local emergency planning committees (LEPCs). In northern Kentucky, three counties came together to form the Northern Kentucky Emergency Planning Committee.

These committees meet at least twice a year to review and approve plans submitted by local industries that house or manufacture hazardous materials. They forward these plans to the Kentucky Emergency Response Commission, the same sponsor of this course, for approval. Once approved, these plans become part of the **local emergency operations plan** for the jurisdiction.

The local emergency operations plan is a comprehensive plan that addresses almost every type of situation that may be considered a disaster. In the state and all local plans, there is a section, called an annex that addresses hazardous materials emergency response. This annex is called "ANNEX Q." The facility plans approved by the LEPC and the Kentucky Emergency Response Commission are placed in the local annex and usually referred to as Tab Q-7 plans.

In the appendix of this book, you will find the KyEOP ANNEX Q and a Tab Q-7 plan from the Mercer County Emergency Operations Plan. These plans are kept at the 24-hour warning point for all counties. It is to your benefit to read this plan and familiarize yourself with the plans for the businesses in your jurisdiction.

One of the benefits of these plans is that it predicts the endangered areas for a particular facility. However, if you have a transportation incident that does not affect a facility, then you must use another resource to determine the endangered areas. This resource is the ERG.

Inside the ERG, there are several difference distances. The real question is which one do you use for determining the boundaries of the endangered area?

Initial Isolation and Protective Action Distance

In the green section, there is a ***Table of Initial Isolation and Protective Action Distances***. This table provides the isolation distances, which can translate to the boundaries of the endangered area, in a 360° perimeter. In addition, the table provides protective action distances, which also indicates the endangered area, but only in one direction, downwind.

The distances in this table are only for hazardous materials that are designated a toxic inhalation hazard (TIH) and the product is not on fire. A TIH is indicated by a highlight of the name, UN/NA id number, and the guide number in the numerical or alphabetical indices.

The table has three columns. The first column is the product identification, indexed by the UN/ID number. The second column, which provides distances for small spills, is divided into three smaller columns: isolation distances, and protective action distances for day and night. The third column provides distances for large spills. It is also divided into three smaller columns: initial isolations distances, and protective action distances for day and night.

Public Safety Distances

If you have a substance that is not a TIH or a TIH that is burning, then you should follow the distances mentioned in the PUBLIC SAFETY section of the orange guides. In many guides, the isolation distances are given in regular typeface. You have to be certain to read the entire section. For example, on Guide 123, under the Public Safety heading, there is an initial isolation distance of 100-200 meters in all directions. Just a note, if you see the phrase “in all directions,” the shape is a circle.

However, if there is fire, then you must go to the distance under the evacuation distance. The point here is that you must **READ THE WHOLE GUIDE BEFORE MAKING A DECISION** on distances.

Determining Concentrations

When you initially arrive at a scene, you cannot be certain of how long the leak has been active, especially if the material is a gas under pressure. In addition, you may not be able to determine the concentration of the material in the area. There are several factors to keep in mind when assessing the concentration. First, determine the physical and chemical characteristics of the material. Determine the environmental factors such as wind or water speed and direction and the lay of the land. Finally, the size of the area where the release occurs is important. It is nearly impossible for you to examine and calculate these things in an effective and efficient manner without forgoing safety. This is why many hazardous material utility software programs have plotting programs. These programs calculate these factors and often others to determine the concentration of a material.

In Kentucky, the Chemical Stockpile Emergency Preparedness Program (CSEPP) counties use the Federal Emergency Management Information System (FEMIS) and the Emergency Management Information System (EMIS) to plot the plume of an accidental release of a chemical weapon. This is updated on increments that can be adjusted.

The CAMEO program also has the plotting feature.

A second option to determining the concentrations of a material is to use detection equipment, such as Draeger Tubes or a gas chromatograph. There are many different types of detection equipment. Some are expensive, while others are very affordable. In this section, you will not learn how to operate them; however, you should be familiar with the equipment of your department or team.

Search and Rescue

As a first responder, you understand the "rush" that overcomes you when a victim is endangered. Your first reaction is to rush in and save the victim(s). However, you learned at the awareness level that rushing in is not the correct way to respond to a hazardous materials incident. There is no quid pro quo in hazardous materials response. It is not appropriate to exchange your life for someone else's.

In order to effect a safe, effective and efficient rescue, you must take other actions prior to the rescue. The guidelines in the emergency response guidebook provide a framework in a response.

Approach the scene cautiously, you cannot help others if you go down because you missed a hazard. Secure the scene, keep people away and isolate the area without entering the area. Be certain to allow enough room for your equipment.

Identify the hazards. Use the available clues. Placards, shipping papers and even the knowledgeable people on scene can provide you with information concerning the presence of hazardous materials and much more.

Assess the situation. Be alert to hazards such as fire, conditions complicated by the weather and terrain, who or what is at risk. Use the answers to these questions to guide your planning process. Also, consider what resources are you have available.

Obtain help. Chances are, you will need assistance from other departments or agencies. You may need to recoup response expense. On the other hand, federal or state law may mandate that you notify the NRC or Kentucky Environmental Response Team.

Decide on entry into the hot zone. Weight the benefits against the risks. Can you make an effective, safe and efficient rescue? If the answer is no, then don't go.

Respond, following your plan. Initiate the Incident Management System. Rescue and evacuate if necessary. Re-evaluate the situation constantly. Are you in unwarranted danger? If so, then you need to back out.

You safety comes first. Use the guidelines above and D.E.C.I.D.E.: Determine the presence of hazardous materials. Estimate the likely harm without intervention. Choose the objectives. Identify action options. Do the best option. Evaluate your progress. The stakes are too high. Your goal should be the same as your partner's, go home to the ones that love you every night. Therefore:

If you are not properly protected, DO NOT GO!!!

The bottom line is that you cannot help someone if you are part of the problem. Safety is the first and foremost priority. Your safety tops that list. Failure to follow the rules your department has developed and the guidelines laid out in this course will result in harm to you, or the people you are supposed to protect.

As an emergency responder to a hazardous materials incident, you must take the time to fully assess the incident. Most of you will not have the proper protective clothing or training needed to wear it to enter a hazardous environment. Firefighter's protective clothing provides limited if any protection to you in a hazardous materials response. Do not let yourself become a victim.

The issue of rescue considerations will surface again later in the course as you identify action options.

APPLICATION 1-1

The next section of this chapter will present you with an opportunity to take the information you have learned and apply it to potential situations. The forms that follow are the Kentucky Division of Emergency Management's Incident Log. This is directly out of the Kentucky Emergency Operations Plan (KyEOP). By the end of this course, you will use all of the KyEM incident log form, including the site safety plan.

Before you begin this section, your instructor will review the layout of incident log with you. You will be expected to work with one or two other people to accomplish this project. There will be up to three scenarios. You will be given 10-15 minutes to begin the process. This application will only last about 1 hour.

Pay close attention to the situation. Remember the steps you have learned to this point. You must first detect the presence of hazardous materials and then estimate the potential of likely harm. Do not do anything beyond this.

KENTUCKY EM INCIDENT LOG										Page 1
GENERAL INFORMATION										
INCIDENT#:	Operations Training1			TIME REPORTED:	12:00 pm					
DATE:				TIME OCCURRED:	11:15 am					
COUNTY:	Greenup			COMMUNITY:	Russell					
INCIDENT LOCATION:	Russell Rail Yard									
TIME NOTIFIED:	11:35 am									
REPORTED BY:	Trainmaster	AGENCY :	B&O Railroad	PHONE:	555-555-0011					
SITUATION REPORT										
# INJURIES:	0	# DEATHS:	0	# EVACUATIONS :						
# SHELTER:	0	LOCATIONS:								
STREAMS AFFECTED:										
PROPERTY DAMAGE:										
ROADWAYS CLOSED/DETOURS (MM):				EXPECTED OPEN:						
EXPECTED ALL- CLEAR TIME:										
WEATHER										
TEMP	85	DEW POINT	65	WIND SPEED/DIRECTION	5 SW	PRECIPITATION (RAIN, SNOW, ETC)				
TYPE OF INCIDENT										
HAZMAT		NATURAL HAZARD		TRANSPORTATION		OTHER EVENT		SEARCH/RESCUE		
SPILL		THUNDERSTORM		RAILROAD		TERRORISM		LOST PERSON		
AIR RELEASE		TORNADO		HIGHWAY		MEDICAL		DROWNING		
FIRE		FLOOD		AVIATION		CIVIL DISORDER		USAR		
EXPLOSION		WINTER STORM		PIPELINE		EVACUATION/SHELTER		MISSING AIRCRAFT		
CSEPP		EARTHQUAKE		MARINE		UTILITY/WATER		HIGH ANGLE		
RADIOLOGICAL		OTHER		OTHER		OTHER		CAVE		
INITIAL INCIDENT INFORMATION										
People reportedly complaining of burning eyes and an acrid odor										
(USE INCIDENT JOURNAL, PAGE 10, FOR CONTINUATION)										
STATE STAFF ROLE:		INCIDENT COMMANDER (WHO)								
INCIDENT ACTION PLAN:	YES		NO		DATE/TIME					
SITE SAFETY PLAN	YES		NO		DATE/TIME					

KENTUCKY EM INCIDENT LOG — Page 2

HAZARD INFORMATION

CHEMICAL NAME	AMOUNT RELEASED/ SPILLED	UN #	GUIDE #	CAS # PLACARD	TOTAL AMOUNT	CHARACTERISTICS		
						FP	LEL	UEL

EHS	YES		N0		RQ (AMT)		CERCLA	YES		NO		RQ (AMT)	

STATE

SOLID		LIQUID		GAS		LIQUID COMPRESSED GAS		PURE		MIX		WASTE		OTHER	

HAZARDS

CORROSIVE		ACTIVE TOXICITY		DELAYED		TOXICITY		FIRE		REACTIVE		SUDDEN RELEASE		RADIO ACTIVE	

RESPONSIBLE PARTY INFORMATION

COMPANY			
CONTACT PERSON			
ADDRESS			
CITY, STATE, ZIP			
PHONE			
E-MAIL			
FAX			

CLEAN-UP CONTRACTOR

CLEAN-UP CONTRACTOR			
CONTACT PERSON			
ADDRESS			
CITY, STATE, ZIP			
PHONE			
FAX			
ETA			

INCIDENT ACTION AND SAFETY PLANS

ACTION PLAN	YES		NO		DATE/TIME	
SITE SAFETY PLAN	YES		NO		DATE/TIME	

INCIDENT ACTION PLAN

INCIDENT PRIORITIES

1ST	LIFE SAFETY	
2ND	INCIDENT STABILIZATION & PROTECTION OF THE ENVIRONMENT	
3RD	PROPERTY CONSERVATION	

WHAT IS THE PROBLEM?

STRATEGIC GOALS

TACTICAL OBJECTIVES

TACTICAL OBJECTIVES	RESOURCE ASSIGNMENT PER OBJECTIVE

PLAN SUMMARY

MITIGATION MEASURES

IMS/UNIFIED COMMAND POSITIONS								
ANNEX Q ACTIVATED	YES		NO		TIME:		DATE:	
ACTIVATED BY:								
STAFF FUNCTION	NAME				TIME ON SCENE		TIME RELIEVED	
IC								
SAFETY								
PIO								
LIAISON								
OPERATIONS								
PLANNING								
LOGISTICS								
FINANCE								
DECONTAMINATION								
MEDICAL								
RESOURCE								
STAGING								
SCIENCE								
COMMUNICATIONS								
OTHER								
OTHER								

PROTECTIVE ACTION ZONES [DESCRIBE]

INITIAL ISOLATION ZONE RADIUS		SAFE REFUGE DISTANCE EMERGENCY WORKERS	
EXCLUSION (HOT) :			
CONTAMINATION REDUCTION (WARM):			
SUPPORT ZONE (COLD);			

DECONTAMINATION AND PPE

ZONE	LEVEL PPE	DECON LOCATION SITES
HOT		
WARM		
COLD		

EMERGENCY EVACUATION SIGNAL(S) AND ROUTES FOR WORKERS

SIGNAL	ROUTE

POPULATION PROTECTION ALERTING/WARNING

METHOD OF ALERT		SIGNAL	
BEGIN EVACUATION TIME	END EVACUATION TIME	IN-PLACE SHELTER/ BEGIN TIME	IN-PLACE SHELTER/ ALL CLEAR TIME

SENIOR LOCAL AGENCY PERSONNEL ON SCENE			SHIFT 1	2
AGENCY	UNIT #	NAME	TIME ON SCENE	TIME RELIEVED
EM				
FIRE				
POLICE				
SHERIFF				
RESCUE				
EMS				
WATER/SEWER				
ROADS				
COUNTY JUDGE/EXECUTIVE				
MAYOR				
NEWS AGENCY				
OTHER				

SENIOR STATE AGENCY PERSONNEL PRESENT			SHIFT 1	2
AGENCY	UNIT #	NAME	TIME ON SCENE	TIME RELIEVED
EM				
FM				
NREPC/ERT				
MVE				
KSP				
DOT				
NREPC/WATER				
NREPC/AIR				
AG/PESTICIDES				
CHS/EMS				
PSC				
KyNG				

PUBLIC SHELTER/EVACUATION INFORMATION

RECEPTION CENTER		PHONE	
RECEPTION CENTER		PHONE	
SHELTER LOCATION		#SHELTERED	
SHELTER LOCATION		#SHELTERED	
SPECIAL FACILITIES AFFECTED:			

COMMUNICATIONS PLAN

AGENCY	FREQUENCY	PHONE	CELL PHONE	FAX
EMERGENCY PUBLIC INFORMATION ALERTING				

AIRSPACE RESTRICTIONS CALL KYDES DUTY OFFICER 800-255-2587

LATITUDE AND LONGITUDE	N3_._____ W08_._____

RECOVERY

RE-ENTRY & RECOVERY	DATE/TIME BEGIN		END	
FOLLOW UP PROCEDURES/ACTIONS	DATE/TIME BEGIN		END	
SCHEDULE CRITIQUE DATE/TIME				
LOCATION OF CRITIQUE				
REPORT FILED DATE/TIME				

NOTES

INCIDENT SITE DRAWING

NORTH

KENTUCKY EM INCIDENT LOG			Page 10
INCIDENT JOURNAL			Page ___ of ___
DATE	TIME	INITIALS	REMARKS

Section Three - Choosing Response Objectives

CHAPTER SEVEN - INTRODUCTION TO INCIDENT MANAGEMENT

TERMINAL OBJECTIVES

Upon completion of this chapter, the student will be able to demonstrate an understanding of what the Incident Management System is in Kentucky, how it is utilized, and the general roles of each major component in the system.

ENABLING OBJECTIVES

By the end of this class, the you will be able to:

1) Given simulated facility and/or transportation hazardous materials incidents, the first responder at the operational level shall initiate the incident management system (IMS) specified in the local emergency operations plan.
2) Identify the role of the first responder at the operational level during hazardous materials incidents as specified in the local emergency response plan and the organization's standard operating procedures.
3) Identify the purpose, need, benefits, and elements of an incident management system (IMS) at hazardous materials incidents.
4) Identify the considerations for determining the location of the command post for a hazardous materials incident.

Whether it is a day-to-day incident or a major catastrophe, the incident management system provides a standardized method to address the challenges of emergency response.
Photo by William Fletcher, Boone Co. EM.

5) Identify the procedures for requesting additional resources at a hazardous materials incident.

INTRODUCTION

When an emergency incident occurs, how do you respond? How do you know what to do? Is it instinctive or reactionary? It is an appropriate question when you think about it. As a member of

an emergency response team, you need to have an understanding of the organizational parameters in which you operate. It does not matter whether you are a law enforcement, public works employee, firefighter, emergency manager, or support service team member such as an amateur radio operator or mass care agency representative; there is a system that you should work within whenever you respond to an emergency.

All state agencies included in the state Emergency Operations Plan, and all local agencies referenced under KRS 39B.050, are required by KRS 39A.230 to use "*an incident command or management system…when responding to the scene of day-to-day, routine emergency incidents.*" In addition, local agencies are required to use "*one unified incident command or management system…when responding to the scene of a multiagency or multijurisdictional emergency, declared emergency, disaster or catastrophe….*" The fire community, especially the wildland firefighting community, first saw the need for a method to manage major incidents. This became known as the incident command system, ICS. However, all incidents need to be handled in a systematic manner. The Kentucky Division of Emergency Management (KyEM)

The Incident Management System allows many different agencies to work together to reduce or stop the threat of a particular hazard, such as this leaking annhydrous ammonia tank car in Winchester on November 22, 2000. Photo by Logan Weiler, Kentucky Division of Emergency Management Area 13 Manager.

has developed this course, actually a set of courses. This course is an introduction into the concepts of the Incident Management System. The next course, *"Principles of the Incident Management"*, is an eight-hour course that provides you with the in-depth aspects of the Incident Management System and how to assume a leadership role with the Incident Management System. For specific disciplines, such as hazardous materials and search and rescue, additional two to four hour modules are being designed to address the specific tactical concerns.

The Purpose of Incident Management

The purpose of the Incident Management System, also known as IMS, **is to enhance emergency worker safety and effectiveness by providing a standardized management system to be utilized in handling all types of emergencies**. IMS is applicable to small day-to-day

operations as well as very large and complex incidents.

IMS can be used in response to any natural or man-made disaster, forest fires, or even parades, large-scale events, and other events that would require the mobilization and coordination of resources, both people and equipment.

The Incident Management System has been developed and customized for the specific challenges faced by Kentucky's emergency responders. However, the roots of IMS can be traced back to the Incident Command System (ICS).

ICS was originally developed as a consequence of wildland fires that threatened large portions of Southern California in 1970. As a result of those fires, a need was identified to develop a system where different agencies could work together toward a common goal in an effective and efficient manner. The ICS consists of procedures for directing personnel, facilities, equipment, and communications.

The National Interagency Incident Management System (NIIMS) was adapted from ICS to provide a common system that emergency service agencies can utilize at the local, state, and federal levels. From the NIIMS course, the Kentucky Division of Emergency Management created the course you have today.

Why do you care about incident management?

The practical answer is that using the Incident Management System permits the combining of agencies into one cohesive team for safe and effective response operations. If you are involved in hazardous materials emergency response, a legal answer is that the federal government passed on the Superfund Amendment and Reauthorization (SARA) on October 17, 1986. As a result of many emergency responders being injured, disabled, or killed while dealing with hazardous materials, one element of SARA was a directive to the Occupational Safety and Health Administration (OSHA) to promulgate worker safety regulations. OSHA met their mandate in a document known as 29 CFR 1910.120, the Hazardous Waste Operations and Emergency Responder (HAZWOPER) standard. As a result, federal and state OSHA regulations mandate the use of an incident management system at every hazardous materials incident. However, if you are not involved in hazardous materials response, a legal answer lies in KRS 39A.230. If your agency or department is included in either a local or the state emergency operations plan, you are required to use "one multirisk, multiagency, unified incident command or management system." If you are attending this course, and a member of an emergency agency or department in Kentucky, then your agency or department is most probably included in either the state or a local plan.

However, the need of managing an incident in an efficient and effective manner is not just for fire or hazardous materials emergencies. Although these emergency incidents can be large, complex operations, many of the other incidents emergency workers respond to have the potential to be large, complex operations. An example of a non-hazardous materials emergency that required a large amount of coordination of resources over an extended period of time is the 1997 flood in the northeastern part of Kentucky. The waters of the Licking River decimated the town of Falmouth. Coordination of handling medical emergencies, evacuation, damage assessment, law enforcement issues, public health issues, housing needs, and a myriad of other situations had to be handled in an expeditious, but efficient and effective way. In 2000, although an emergency was not declared, when an eight-inch water main ruptured, interrupting the majority of the city's water supply and destroying the city's gas main, the incident management system provided an

organized approach to dealing with whole incident for the city of Newport.

When the floods hit Kentucky in 1997, many communities looked like Lebanon Junction. The use of the incident management system provided effective and efficient use of the available resources. Photo from KyEM Archives.

Components of the Incident Management System

The primary objective of the Incident Management System is the application and management of assigned resources to safely, effectively, and efficiently achieve incident control for any situation. In order to do this at an emergency incident; a definite chain of command and a clear line of communications are essential because of the potential for disaster to personnel and property.

Incident management begins from the inception of an incident and continues until incident management and operations are no longer needed. At that point, the Incident Management System is terminated. To meet the objective of IMS, there needs to be several common, but essential components. These components are

1. Common terminology
2. Modular organization
3. Integrated communications
4. Command
5. Consolidated action plans
6. Manageable span of control
7. Designated incident facilities
8. Comprehensive resource management.

If this sounds like very technical language and perhaps may seem like too much to learn in one class, you are absolutely correct. This is why incident managers are the most senior and experienced persons. Nevertheless, it is important that you understand the individual components.

1. Common Terminology

The terminology that is used during an incident when the Incident Management System has been implemented is designated so that the various responding agencies can clearly and efficiently communicate. For example, if there was not common terminology and you were to request a comms unit, you might receive anything from a handheld radio to a vehicle used to provide the major part of an incident communications center.

Common terminology provides standardized and consistent definitions for major functions, functional units, resource elements, and facilities. Here are a few examples of these terms:

1. **Incident Manager** – The incident manager is the individual responsible for the management of all incident operations.
2. **Operations Section Chief** – The Operations Section Chief assists in developing and implementing incident strategy and is responsible for the direct management of all tactical activities.
3. **Logistics Section Chief** – The Logistics Chief manages those units which provide all support needs for an incident, including personnel, apparatus, equipment, facilities, etc.
4. **Division, Group or Sector Supervisor** – The Division, Group or Sector Supervisor commands and supervises geographic divisions or functional groups within a defined area.

2. Modular Organization

The organizational structure of IMS develops in an expanding or contracting modular fashion based on the kind and size of the particular incident. If one person can simultaneously manage all major functional areas, no further organization is required; although it is possible that the incident manager, while retaining command, can delegate the functions of command; such as operations, planning, logistics, and finance. However, the incident manager is responsible for performing the functions of any position that are not designated to someone else.

In many cases, the incident manager may begin performing all functions. However, as the complexity or time of the incident increases, the incident manager can pass off some or all of the functions to those qualified to provide assistance. Position titles used in the Incident Management System are selected to provide unique identification of the *functional level* designated. This modular organizational structure and corresponding position titles do not generally follow those of any particular agency.

In an incident, the first management assignments delegated by the incident manager will normally be one or more section chiefs to manage the major functional areas as needed. These include, Operations, Planning, Logistics, and Finance. Section chiefs will further delegate management authority only for their areas if that is required.

3. Integrated Communications

Imagine this scenario: you are the incident manager for a large scale incident. It could be a fire, a hazardous materials incident, a search and rescue mission, etc. You send out a team to size up (assess) the incident. They go out and come back to report. Their mouths begin moving, but you cannot hear a single word they are saying. Or they come back and are speaking a “foreign language,” full of technical references unknown to you.

Perhaps your situation is closer to this; you have a large-scale incident in your community. Every emergency agency in the area responds to help; yet you do not have the capability needed to talk

directly to them to provide direction. Or, each agency sends a representative to the command post, and it seems that you have more people in the command post than you have helping on scene.

Does this sound ridiculous? Perhaps not… Unfortunately, a breakdown in communications

When this distillery warehouse burned in Anderson County during May 2000, spilling over 250,000 gallons of aging whiskey into the Kentucky River, emergency responders ranged from the public health department to fish and wildlife personnel, as well as EMS, police, fire, and emergency management personnel. The incident management system provided the framework to address the multiple hazards of the fire, the subsequent loss of public utilities, and significant environmental impact were handled.
Photo courtesy of Natural Resources and Environmental Protection Cabinet.

happens more often than anyone is comfortable with. This is why integrated communications are so important. Communication at an incident should be managed through a common communications plan and an incident based communications center. Ideally, the communications plan should be developed and tested prior to an actual incident.

All communications between organizational elements of agencies should be conducted in plain English, which incident managers call “plain text.” This means no codes, 10 codes, or abbreviations. The reason for this is simple; not everyone uses the same definitions for the codes you may use. In some parts of Kentucky, a 10-46 is a motor vehicle accident with injuries, while in other parts, a 10-50 PI is a motor vehicle accident with injuries, yet in other places a signal 4 is a motor vehicle accident with injuries.

There is another important aspect of the integrated communications element. This is common communication frequencies. For example, the command elements, (i.e., the incident manager, safety officer, and section chiefs) should be on a common “command” frequency. No one else should use this frequency to communicate. Instead, the sections should have dedicated “tactical” frequencies for their use. Likewise, you may not have the luxury of having multiple radio channels, therefore, only key personnel will be given the ability to communicate on common frequencies. The determination of how the radio networks are set up should be a joint planning, operations,

and logistics function.

4. Command Structure

A command structure could consist of a key responsible official from each jurisdiction in a multi-jurisdictional incident. In a single jurisdiction, a command structure could also consist of several agencies. The command structure can be described as ***command by committee,* or better, "unified command."** This command structure is very effective and adaptable. Not only does it include experienced representatives from the various emergency response organizations, but it is able to adapt to include other organizations such as the landowner, National Guard, or private industry in the incident management process. The composition of the command structure will depend on the magnitude and location of the incident, as well as the length of time of the incident.

5. Consolidated Action Plans

For any incident, the Incident Manager will establish objectives and make strategic decisions for the incident based on the requirements of the jurisdiction. For a small incident, such as an isolated structure fire or a single traffic accident, a consolidated action plan is usually not written down. However, in the case of a Unified Command, the incident objectives should be written down and distributed for all participants to see. These objectives must adequately reflect the policies and needs of all jurisdictional agencies. The consolidated action plan should cover all tactical and support activities required for the operational period. The Kentucky Division of Emergency Management has standard forms that help the incident manager develop this action plan. These forms are included in the appendices of this book.

6. Manageable Span of Control

Generally speaking, within the scope of incident management, the number of personnel under the span of control of any individual in an emergency should range from three to seven, **with five being established as an ideal span of control.** Of course there will always be exceptions, since safety practices and sound management planning will influence and dictate span-of-control considerations. For example, large law enforcement agencies will sometimes have supervisors with more than five personnel under their span of control. When determining span of control limits, you must anticipate change and prepare for it, especially in a rapidly escalating incident. In addition to the Span of Control concept, there is concept called "Unity of Command." This ensures that individuals will have only one supervisor.

7. Designated Facilities

The use of designated facilities facilitates the advance preparation for incidents. Communications equipment, computers, reference materials, and usually easy access are all givens with a designated incident command post. Other facilities should also be designated such as staging points for equipment and supplies; water fill points. The actual incident facilities required, and their locations, will be based on the requirements of the incident and the direction of the Incident Manager. Below are definitions of many of the designated facilities.

A) Command Post – The command post can be as simple as the hood of the first arriving unit with a portable radio. Longer duration incidents may warrant the deployment of a mobile command post equipped with radios, weather monitoring and other sophisticated equipment. Many local emergency management agencies in Kentucky have developed mobile command posts. The Kentucky Division of Emergency Management has a mobile command post, which can be requested by calling the state emergency operations center at (800) 255-2587. It is important to note that there should be only one command post for the incident. The

command post should be established immediately even if it does not provide an ideal facility. You can always relocate after the initial operations are underway. Keep in mind when establishing a command post to locate it in a safe place. Explosions, BLEVE's, and various other dangers do not discriminate. Also, do not be afraid to relocate the command post.

There are five major functional areas in the Incident Management System: Command, Operations, Finance and Administration, Logistics, and Planning. Can you identify the area that each person in the picture is assigned to?
Photo by William Fletcher.

Better facilities, such as a building, may be desired because of the length of time of the incident, communications problems, or a need for more space. In addition, Kentucky Vehicle Enforcement weigh stations may be used as command posts for incidents along the interstates and parkways of the Commonwealth.

B) **Staging Area** – This is a **safe haven for personnel and equipment** that allows a response to the scene within three minutes of request while providing protection should the incident intensify. Staging areas are important to efficient operations. It cannot be more frustrating for a person to know you have something that can help you go home quicker, and then not be able to find it. The staging area provides a way to prevent sending all available or responding equipment and personnel to the central incident area. Again, safety will dictate where to locate your staging area. If there is a possibility of a hazardous material release or flooding for example, you will want to put your staging area upgrade, upstream, and upwind. If there is potential for a gunfight, you will want to be in a safe area, possible out of sight of the perpetrator. The person in charge of the particular responding unit or organization will communicate with the staging manager to check in and stand by for assignment. Each staging area must have a manager with radio or phone contact with the command post.

C) **Incident Base** – The incident base will house all uncommitted equipment and personnel support operations not expected to respond within three minutes. There should be only one

incident base. Normally the incident base will not be relocated; so initial positioning should take into consideration the worst case scenario. The incident base can provide feeding, sleeping, along with equipment and vehicle maintenance support.

D) Camps – On major, long-term incidents, camps are established to provide essential support operations such as feeding, sleeping, sanitation, minor equipment maintenance and servicing especially in areas far removed from the incident base.. Forest fires require camps often to rehabilitate the responders on the front lines.

E) Helispots or Heliports – Helispots are temporary landing zones for helicopters. The specific size of a helispot must be confirmed with the individual helicopter service providers. Helispots can be used in any sized incident. However, they are more common with medium to large-scale incidents. Although it will depend on what the nature of the incident is, helispots can be located by triage areas, camps, staging areas, or the command post. It is important to consider the effects of rotor wash, the powerful winds created by the turning of the blades, as you decide where to establish helispots. Heliports are complex and may involve fueling and maintenance capabilities.

8. Comprehensive Resource Management

Resources can be managed in different ways. The three most common ways are single resources, task forces, and strike teams. Strike teams and task forces are formed to meet specific needs of the incident. Each will have leader and common radio frequencies.

This strike team was used to help fight the fire in McCreary County during 2000. A strike team is a group of the same type of resources put together to become useful tactical resources. Photo by Malcolm Franklin KyEM Area 12 Manager

Single Resources – These are individual people, units or crews that will be assigned as primary tactical units. A single unit will consist of the equipment and the personnel needed to properly operate it. A single unit may be a fire engine with a crew of three firefighters from the Salvisa

Volunteer Fire Department.

Task Forces - Task forces are different kinds of single resources required to meet specific tactical needs. They should be disbanded and returned to service as single resources when the task force is no longer needed. An example of a task force would be a drug enforcement unit that consist of a hazardous materials specialist, law enforcement public health officials and fire officers who respond together to clandestine methamphetamine laboratories.

Strike Teams – These are resources of the same kind or type put together to become useful tactical resources. An example of strike teams would be the group of wildland firefighters that converged on McCreary County during the 2000 fire season.

Also, it is important to understand the status designations that resources might receive. If a unit is **assigned**, that unit is performing an active assignment. If a unit is **available**, that unit is immediately available to be assigned. Usually those resources available are in the staging areas. If a unit is **out of service**, that unit is not ready for available status or assignment. In the Incident Management System, the optimum duty shift is twelve hours on duty, twelve hours off during an extended incident.

Roles and Responsibilities of the Major Functional Areas

In order to make the Incident Management System function properly, every responder needs to understand the major functional areas of the Incident Management System. An IMS organization has five major functional areas: Command, Operations, Planning, Logistics, and Finance. In a small incident, the Incident Manager typically performs all functions. In a medium-scale incident, the incident manager may delegate responsibility for the functions to two to five individuals. In a large-scale incident, many people may be assigned to staff each of the functional areas under the direction of a Section Chief. It is extremely important to **think of each area as a function to be performed** and not a person or a unit.

Below is a description of the scope of the major functional areas.

Command

The Command function is responsible for overall management of the incident. However, the ultimate responsibility for the incident lies with the top elected official for the specific jurisdiction as specified in the Kentucky Revised Statutes. There are two types of command, single and unified. In a single command structure, a single Incident Manager is solely responsible, within the confines of authority, to establish objectives and overall management strategy associated with the incident. In a unified command structure, the individuals designated by their jurisdictions, or by departments within a single jurisdiction, must jointly determine the objectives, strategy and priorities. Hence the name, unified command.

In a single command structure, the incident manager will prepare incident objectives that in turn will be the foundation for the subsequent incident action plan. The incident manager is directly responsible for follow-though to ensure that all functional areas are working toward the accomplishment of the strategies and tactics determined in the incident action plan.

Imagine this scenario, a vehicle catches fire on Lancaster Avenue in Richmond. The fire blocks all traffic near the main entrance to Eastern Kentucky University. In addition, while attempting to see the reason for the traffic delay, hits a second car causing a motor vehicle accident with injuries. In this case, the fire department will take care of the car fire and extricate the victims if required. In addition, the EMS crew will take care of any injured vitcims. The fire department will

handle traffic control until the police arrive on scene. All of the responding units are under the direction of a battalion chief or fire captain. This situation is an example of single command structure.

Compare the above incident to a tornado strike in Western Kentucky. A tornado (emergency management) spills a full fuel oil tank (hazardous materials response team) in the ground endangering the water table (Division of Water), causes a power failure (utility company), and destroys several homes (Red Cross and National Guard) injuring several people (emergency medical services). All of these agencies could be coordinated through an Emergency Operations Center (EOC), using the unified command structure.

The unified command structure is called for when more than one department or agency shares management responsibility due to the nature of the incident or the kinds of resources required. For example, in a tornado strike, fire, law enforcement, and emergency management personnel all have immediate, but different, objectives. In order to determine the best course of action for the overall incident management, it is best if the objectives, strategy, and priorities are jointly determined. By mutual agreement, executive order, or legislation, the department or agency with the overall operations responsibility will be determined. The operations chief will be representative of the selected agency. A unified command structure is also necessary when the incident is *multi-jurisdictional* in nature. There must be an interface between the emergency operations center and the incident manager.

Returning to the tornado scenario, what if this tornado hits Harrodsburg (City property), follows US 68 East toward Burgin (County property) and continues to Jessamine County (neighboring county). In this case you will have several different jurisdictions, Harrodsburg City, Mercer County, and Jessamine County, involved in the incident. In this case, two emergency operations centers would be activated, Harrodsburg/Mercer County and Jessamine County. Each EOC would operate under the unified command structure and communicate with each other.

Command Staff Structure

Command staff positions are established to assume responsibility for key activities that are not a part of the line organization. Here is a brief description of the three identified command structure positions, the **safety officer, the information officer, and the liaison officer**.

Safety Officer

On hazardous materials incidents, the use of a safety officer is required by legislation, SARA Title I and the Hazardous Waste Operation and Emergency Responder regulation. The National Fire Protection Association guidelines and the Kentucky State Fire Commission strongly suggest the use of a safety officer on the fireground. However, common sense mandates the use of a safety officer.

The safety officer's responsibilities are to **identify and evaluate hazards** and to **provide direction** with respect to the safety of operations for the emergency at hand **resulting in a written site safety plan**. The safety officer is responsible for designating access points to the scene, particularly if it is a hazardous materials incident. The safety officer is also responsible for tracking those who enter and exit the inner perimeter of the incident. In addition, the safety officer may have added responsibilities depending on the particular incident.

The authority of the safety officer is very powerful. If the Safety Officer judges that response activities are unsafe and pose imminent danger, the Safety Officer has the **authority to alter,**

suspend, or terminate those activities, and then must inform the Incident Manager of that action. A single Safety Officer should be designated. Assistants may be assigned from other agencies involved in the unified incident command. Again, this will be dependent on the needs of the particular incident.

The Public Information Officer is an important asset to the incident management system. The PIO provides the information to the press. Photo from KyEM files.

Information Officer

Information management is an important aspect of incident management. Persons are able to distribute information to a large volume of persons, including the media within minutes, if not seconds. Likewise, information is generated by various sources and sent into the command post. It is the primary responsibility of the Information Officer to gather accurate and complete information regarding the incident cause, size, current situation, resources committed and other matters of general interest. The Information Officer will then process and distribute that information to various groups including: the command staff, elected officials, and the media. Whether it is a single or unified command structure, only one Information Officer would be designated. Assistants may assigned as required from other agencies or departments involved. All response personnel should be instructed to direct media questions to the Information Officer and to refrain from providing information or opinions regarding the incident.

Liaison Officer

The liaison officer's responsibility is possibly the most difficult and most important aside from the Incident Manager. The Liaison Officer's function is to be a point of contact for the representatives from other agencies, including mutual aid departments, state agencies and families of victims. The Liaison Officer is a buffer for the Incident Manager. In a single command structure, the representatives from assisting agencies would coordinate through the liaison officer. In a unified structure, representatives from agencies not involved in the unified command would coordinate though the liaison officer. It is important that all agency representatives assigned to an incident should have the authority to speak on all matters for their agency.

Operations

Operations at the incident include all activities that are directed toward the reduction of the immediate hazard, establishing situation control, and restoration of normal operations. The operations of an incident are concerned with the tactical actions taken to meet the objectives. However, there are many ways that incident tactical operations may be organized and accomplished depending on the type of incident, the agencies involved, the objectives, and the

strategy chosen. IMS allows extensive flexibility in organizing tactical operations, allowing for difference in jurisdictional boundaries, functional needs, and combinations of functional / geographical considerations. In control of the operations function is the operations section chief.

The overall operation maybe organized into geographical "divisions" and functional "groups." These divisions and groups are established when the number of resources exceeds the span of control of the operations section chief. The best use of the geographical divisions, for example, "north sector" and "south sector," is to divide the area of operations into natural separations of terrain and geography so that resources can be managed under the span-of-control guidelines. Functional groups, e.g. fire suppression, victim relocation, or triage, are the more common method of dividing resources because they can be used to describe areas of like activity or functions. A method of further dividing resources for better control, especially on larger, multi-jurisdictional incidents is the use of "branches."

For example, imagine the incident at the Wild Turkey Distillery in Anderson County in May, 2000. A warehouse holding 250,000 gallons of whiskey caught fire. As a result, most of the 250,000 gallons of whiskey ran downhill into the Kentucky River upstream from the City of Lawrenceburg water plant's intake, forcing a shutdown of the water system for the southern half of Anderson County. If you have ever been on a large incident such as this, you can probably imagine the responding agencies that were present, a virtual alphabet soup of emergency responders. EMS, the fire department, SFM, ATF, F&W, KyEM, NR/ERT, EP/DOW, KSP, LPD, ACSO, and the list goes on. The incident crossed jurisdictional boundaries and included a response from several federal, state, and local agencies. This incident would be a good one to use the branch type division due to the *multi-jurisdictional* response.

Operations Section Chief

The incident operations section chief is responsible for the direct management of all incident tactical activities and assists in the formulation of the action plan. An operations section chief should be designated for each operational period during the incident. The length of the operational period will vary depending on the type of incident and available personnel. The operations section chief will have the last word on what tactics will be used to implement the plan.

Planning is an essential part of the incident management process. This is the second incident management meeting that took place during the Newport water main rupture. Photo from KyEM Files.

Planning

Planning is responsible for the collection, evaluation, and dissemination of tactical information about the incident and compiling the written incident action plan. This section maintains information on the current forecasted situation, and on the status of resources assigned to the incident. The Planning Section Chief will usually be from the jurisdiction that has the primary incident responsibility. Planning duties include checking in all assigned personnel and resources for tracking

their current status. An effective planning section will develop an accountability system to monitor the assignments of all personnel on scene that ensures the safety of all emergency workers.

The Planning Section also collects, processes, and organizes data, preparing summaries and developing projections related to the incident. The Planning Section may be divided into special units for tasks such as situation reporting, resource tracking, and demobilization.

Logistics

The Logistics Section is one of the unsung heroes of the Incident Management System. This section coordinates all support resources and provides facilities, transportation, supplies, equipment maintenance, fueling, feeding, communications, and medical services. This section is also managed by a section chief who is responsible for ordering, receiving, storing and processing all incident related resources, personnel, and supplies. Responsibilities also include establishing, setting up, maintaining and demobilizing all facilities used in the support of incident operations, such as the command post, incident base, relocation centers, shelters, and personnel support facilities. The logistics section is also in charge of acquiring vehicles and equipment and keeping them fueled and running. Communications equipment and facilities also fall under the purview of the logistics section, as does providing food and water and maintaining the food service area. Finally, the logistics section is responsible for the medical services for incident personnel injuries, transportation and processing paperwork.

Finance and Administration

Finance is established on incidents when the agencies that are involved have a specified need for financial services, such as accessing state or federal funds for clean up. The finance section provides an organized, systematic approach to recover costs incurred in the emergency response. This section is responsible for seeking monies from the appropriate sources and dispensing them according to demonstrated need. **Not all incidents will require the establishment of a Finance Section.** If a finance section is established, the Finance Section Chief should be designated from the jurisdiction or agency that has the primary financial burden for the incident. The Finance Section Chief should work closely with the "responsible party." An example of a "responsible party" would be the water company after wide spread damage due to a water main break. The finance section is responsible for daily time-keeping, all financial matters pertaining to vendor contracts, all forms required by Worker's Compensation and local agencies, maintaining accurate information on the actual cost for the use of all assigned resources, such as salaries, equipment depreciation, resources consumed, etc.

KENTUCKY'S EMERGENCY OPERATION PLAN (EOP)

Authors note: This section is about the emergency operations plan. Kentucky's plan is used as the example. However, it strongly recommended that the local jurisdiction's plan be reviewed.

The Kentucky Emergency Operation Plan (KyEOP) is a living document. This plan is a large document that covers how to handle just about any emergency that could affect the Commonwealth of Kentucky. The plan is officially approved by each governor through an executive order; Kentucky's Division of Emergency Management is charged with coordinating implementation of the plan, whenever it is needed. The whole document is too large to discuss in detail within the time of this class. However, it is important that you, the first responder, understand some key portions of the plan.

The KyEOP consists of an introduction, record of change page; the Governor's Executive Order, and the table of contents followed by the basic plan and functional chapters or "annexes." The basic plan essentially lays out the threats, the mission, the concept of operations, the various agency responsibilities, and certain appendices. Annexes provide specific responses for agencies of government and define their responsibilities.

The Standard Operating Procedures (SOP's) required for the implementation of the KyEOP are not included because of the voluminous nature of the SOP's. SOP's are the detailed operating

When severe weather strikes the Commonwealth, there are preplanned written procedures that direct the actions of state and local agencies. Annex D of the state emergency operations plan has emergency actions for tornadoes, floods, earthquakes and even conventional war. Photo from KyEM Archives.

procedures of independent departments and agencies and are maintained by those independent departments and agencies. It is essential for you to read the SOP's for your particular agency, department, or jurisdiction. It is better to be prepared than to try to figure out what is expected of you in the heat of an incident.

The Kentucky Division of Emergency Management (KyEM) and those agencies and departments having emergency assignments undertake an annual review of the KyEOP. The Kentucky Division of Emergency Management maintains a list of all planholders in order to provide updates on an annual basis. Copies of the Kentucky Emergency Operations Plan are also maintained by your local emergency management director and judge executive.

This plan requires fair and equal treatment to all regardless of race, creed, color, national origin, sex, age, or handicap. First priority will always be to save life with mitigation of environmental and property damage coming second and third respectively.

The plan directs the state to conduct all response and recovery operations using the incident command system. The plan guides the Integrated Emergency Management System, which is

the cornerstone of Kentucky's emergency and disaster preparedness, response, recovery and mitigation program. This plan includes both governmental and non-governmental organizations. This plan, including updates, remains in effect from the time it was adopted until the Governor issues an Executive Order stating it is no longer valid.[1]

The Basic Plan

The basic plan is authorized by federal and state legislation as well as Presidential and Gubernatorial orders as described in the first section. The second section of the plan contains the situations and assumptions that the state may face, which in turn, the plan covers. This section addresses threats posed by weather, terrorists, hazardous materials, geologic faults, as well as other situations that may occur creating mass casualties or mass fatalities. The assumptions are simply assumptions that are made to set the stage for the rest of the plan. Items like, "local governments will fully commit their resources before requesting assistance from the state." And, "severe weather…and other natural disasters will continue to occur annually in the Commonwealth." The next section of the basic plan is the mission. This lays out the working priorities of the Kentucky state government in most crises that may arise. The direction and control section outlines the flow of command in the case of an emergency. The concept of operations section defines the scope and applicability of the plan and also where funding may come from should it be needed in handling an emergency. It also defines when the plan should be enacted and guidelines for emergency communications, public information, and operational time phases. The responsibilities of governments (local, state, and federal) are explained, as are the responsibilities of private agencies and businesses.

The last section of the basic plan outlines the responsibilities of state government cabinets, departments, and agencies. This is the most detailed and lengthy section of the basic plan. This section is also summarized in the second appendix. This appendix has been provided for your convenience.

Annex Designation	Subject Covered
Annex A	DIRECTION AND CONTROL
Annex B	COMMUNICATION
Annex C	WARNING
Annex D	INCREASED READINESS

Annex E	PUBLIC INFORMATION
Annex F	RECEPTION AND CARE
Annex G	MILITARY SUPPORT
Annex H	TRANSPORTATION
Annex I	RADIOLOGICAL PROTECTION
Annex J	LAW ENFORCEMENT
Annex K	FIRE SERVICES
Annex L	SEARCH AND RESCUE SERVICES
Annex M	HEALTH AND MEDICAL
Annex N	MANPOWER
Annex O	RESOURCE MANAGEMENT
Annex P	ENERGY SUPPLY MANAGEMENT
Annex Q	HAZARDOUS MATERIALS
Annex R	ENGINEERING & PUBLIC WORKS
Annex S	FOOD MANAGEMENT
Annex T	VOLUNTEER ORGANIZATIONS
Annex U	REPORTING SYSTEM
Annex V	RECOVERY OPERATIONS
Annex W	TRAINING & EXERCISING
Annex X	FIXED NUCLEAR FACILITIES
Annex Y	N.B.C. AND CONVENTIONAL WAR
Annex Z	EMERGENCY REPATRIATION
Annex AA	TERRORISM
Annex BB	AGRICULTURAL RESOURCES
Annex CC	WATER RESOURCES
Annex DD	EARTHQUAKE PREPAREDNESS
Annex EE	EVACUATION
Annex FF	AIRCRAFT ACCIDENTS
Annex GG	DAM FAILURE
Annex HH	CIVIL DISTURBANCE

Each annex provides expanded information on the named subject. These annexes provide the information for the titled subjects in the same format as the basic plan.

This course cannot adequately equip you to use the EOP. It is only the intent of this course to make you aware of the plan and its general form. Again, you are strongly encouraged to get a copy of your local plan and closely study it. Contact the local emergency management director, local emergency planning committee or KyEM Area Manager to learn more about your plan and

the state plan.

Review

Now that you have been introduced to the concepts of Incident Management System, it is time to review the information you have been given. The **purpose of the incident management system**, IMS, is to provide a standardized management system to be utilized in safely and effectively handling all types of emergencies in all jurisdictions. IMS is applicable to small-scale and large, complex incidents. The use of IMS by all Kentucky responders is mandated by KRS 39E and the Hazardous Waste Operations and Emergency Responder regulation during hazardous materials. However, the use of an IMS is required by KRS39A.230 and goes well beyond hazardous materials incidents.

The **major components of IMS** are common terminology, modular organization, integrated communications, unified command, consolidated action plans, a manageable span of control, designated incident facilities, and comprehensive resource management. The **primary objective of IMS**, which is the application and management of assigned resources to effectively and efficiently achieve incident control for any situation.

The **major function areas of the incident management system** are command, logistics, planning, finance, and operations. Command is responsible for the overall management of the incident. There are **two types of command structures**, single and unified. In the **single command structure**, one incident manager is solely responsible to establish the objectives and overall management strategy associated with the incident. In a **unified command structure**, there are individuals designated by their jurisdictions or departments work together to establish the objectives, strategies, and priorities. This alludes to the name, command by committee.

The **command staff structure** consists of the incident manager, liaison officer, information officer, and safety officer.

The **safety officer's responsibility** is to identify and evaluate hazards and to provide direction with respect to safety of the operations. The safety officer has the authority to alter, suspend, or terminate any activity that may be unsafe or pose imminent danger.

The **public information officer** is responsible for gathering accurate and complete information. He or she is the point of contact for the media. The **liaison officer** is responsible for being the point of contact for the representatives of other responding agencies.

The **operations section** is responsible for all activities that are directed toward the reduction of the hazard, establishing situation control, and restoration of normal operations. The head of the operations section is the operations chief. Next in the chain of command are **group leaders**, and then task forces, strike teams or individual units. **Task forces** are different kinds of single resources required to meet specific tactical needs. **Strike teams** are like kinds of single resources assigned together to accomplish tactical resources.

The **planning section** is responsible for the collection, evaluation, and the dissemination of tactical information about the incident. The **logistics section** coordinates all support resources and provides facilities, transportation, supplies, equipment maintenance, fueling, feeding, communications, and medical services for the incident responders. The **finance section** provides an organized, systematic approach to recover costs incurred in the emergency response. The finance section **may not be established on every incident.**

The **command post** should be established immediately. It can be as simple as the hood of the

first unit in and a handheld radio or as complex as a mobile home complete with computers and powerful base stations or a building. **Safety dictates** on where to establish the command post, although it can be moved. **Staging areas** are safe havens for personnel and equipment expected to respond to the scene in three minutes. The **incident base** will house all uncommitted equipment and personnel not expected to respond to the scene within three minutes. **Camps** are used for long-term events to provide support operations such as feeding and sleeping. **Helispots** are temporary landing spots for helicopters. Exact sizes and location requirements should be discussed with the local helicopter service provider.

The **emergency operations plan** is a document that provides guidance on how to handle just about any emergency that could possibly affect the Commonwealth of Kentucky. It has two functional parts, the basic plan and annexes. The **basic plan** descries the threats possibly faced by the Commonwealth and lays out the methods of managing those realized threats. It also gives lists the threat and best agency to deal with that threat. The **annexes** provide functional information and expand upon the concept of operations contained in the basic plan. Annexes also provide specific responses for agencies of government and define their responsibilities.

helispots, staging areas, and single resources.

5. When given a local contingency plan, operate within the guidelines of that plan, using the resources provided in the plan.
6. Properly terminate an incident, to include an after action report (AAR).

CHAPTER EIGHT – PLANNING THE RESPONSE

Terminal Objective

By the end of this chapter, you will be able to develop and determine the defensive objectives for a safe, effective and efficient response.

Enabling Objectives

By the end of this course, to a proficiency of 70%, you will be able to:

1. Given an analysis of a hazardous materials problem and the exposures already lost, identify the steps for determining the number of exposures that could be saved by the first responder with the resources provided by the authority having jurisdiction and operating in a defensive fashion. Identify steps for determining the number of exposures that could be saved.
2. Given an analysis of a hazardous materials incident, describe the steps for determining defensive response objectives.

Introduction to Planning the Response Objectives

You have just learned a little about the Incident Management System (IMS). Now you will learn what you as the incident manager or as a member of the incident management team must do to make a safe, effective and efficient response. As the incident manager for the hazardous materials emergency, you will have to determine the objectives that your team is able to accomplish given their training and equipment. You are responsible to see that the people who are following your directions are able to go home to the ones that love them.

When setting objectives, whether it is for a training manual or an emergency response, you must assess what is your scope of practice based on the level of training and equipment available.

If you were writing a training manual for basket weaving, it would be unreasonable to include objectives on sculpture. Likewise, if you are determining response objectives for a group of hazardous materials first responders trained to the awareness and operations levels, you do not put in offensive objectives.

Steps for Identifying Response Objectives

You will have to make some quick, but informed decisions concerning the direction you want to take your response. There are not any absolute methods for determining the response objectives. However, there are a few questions that you should ask yourself, or your incident management team, to flesh out the assessment.

Is this an emergency? It may seem like a simple accident. However, this is a trailer loaded with 10,000 pounds of smoke grenades. Would you recognize this as a hazardous materials emergency if you saw it?

Does an Emergency Actually Exist?

What constitutes an emergency? As a hazardous materials first responder, an emergency should be defined as an incident where a substance is unreasonably threatening or has the potential to unreasonably threaten the health of people, the

environment or property.

As an emergency services worker, you answer this question on every run you make. Sometimes, this can be done based on the information your dispatcher gives to you. Sometimes, you will have to arrive on scene to determine to what extent there is an emergency. If no emergency exists, do you need to respond? If there is not any hazardous materials present, is there really a hazardous materials emergency?

IF NOTHING IS DONE, WHAT ARE THE CONSEQUENCES?

You understand that everything seeks stabilization. You also understand that in the field of hazardous materials response, there are circumstances when the best actions are to take no action at all. You have been given enough information by this point in your training to use you experience and certain tools to reasonably predict the outcomes of an incident if you do nothing. Perhaps the tank car or facility tank will explode. Perhaps it will not. You must DECIDE.

WHAT ACTIONS HAVE THE INDIVIDUALS ON SCENE TAKEN BEFORE YOUR ARRIVAL?

What has the fire department done? What has the police department done? What has the public works department done? What have the bystanders done? These are important questions. They may not have developed the same action plan as your team's. In addition, you may be taking responsibility for the scene and the already initiated actions. If something should not comply with standards, then you are responsible. Take a look at the incident below:

In the early 1990's, state police troopers in a state on the East Coast were the first to arrive on scene of a hazardous materials accident in January. The chemical spilled was epichlorohydrin. The troopers recognized and identified the presence of the hazardous materials. They secured the scene and notified the proper authorities. Once the incident was terminated, these troopers returned to duty. Twenty minutes later, they were dead due to being overcome by toxic fumes.

If one person had asked these troopers what they had done prior to the arrival of the hazardous materials team, they would have discovered that these troopers were contaminated and probably saved their lives. Likewise, you must receive a full report of the existing operations before you determine how to proceed.

HAVE THE HOT, WARM AND COLD ZONES BEEN IDENTIFIED?

This feeds into the previous question. What actions have been completed?

WHO IS MAINTAINING PERIMETER CONTROL?

This becomes an important question, especially if bystanders are assisting. You need to know whom and what is committed. Otherwise, you will end up counting on resources that are possibly committed elsewhere. Personnel changes may be part of your objectives.

WHAT ARE THE RISKS?

Risk analysis is the greatest single consideration you will have to do when choosing your objectives. The essence of the question is: is the risk to great to allow a safe, effective and efficient response? If it is, then you must change the objective.

WHAT RESOURCES ARE NEEDED?

This is equipment as well as personnel. Does you unit have the proper personal protective equipment (PPE)? Do you have the appropriate support personnel (medical teams, technical advisors, trained responders, emergency management and law enforcement and fire personnel)?

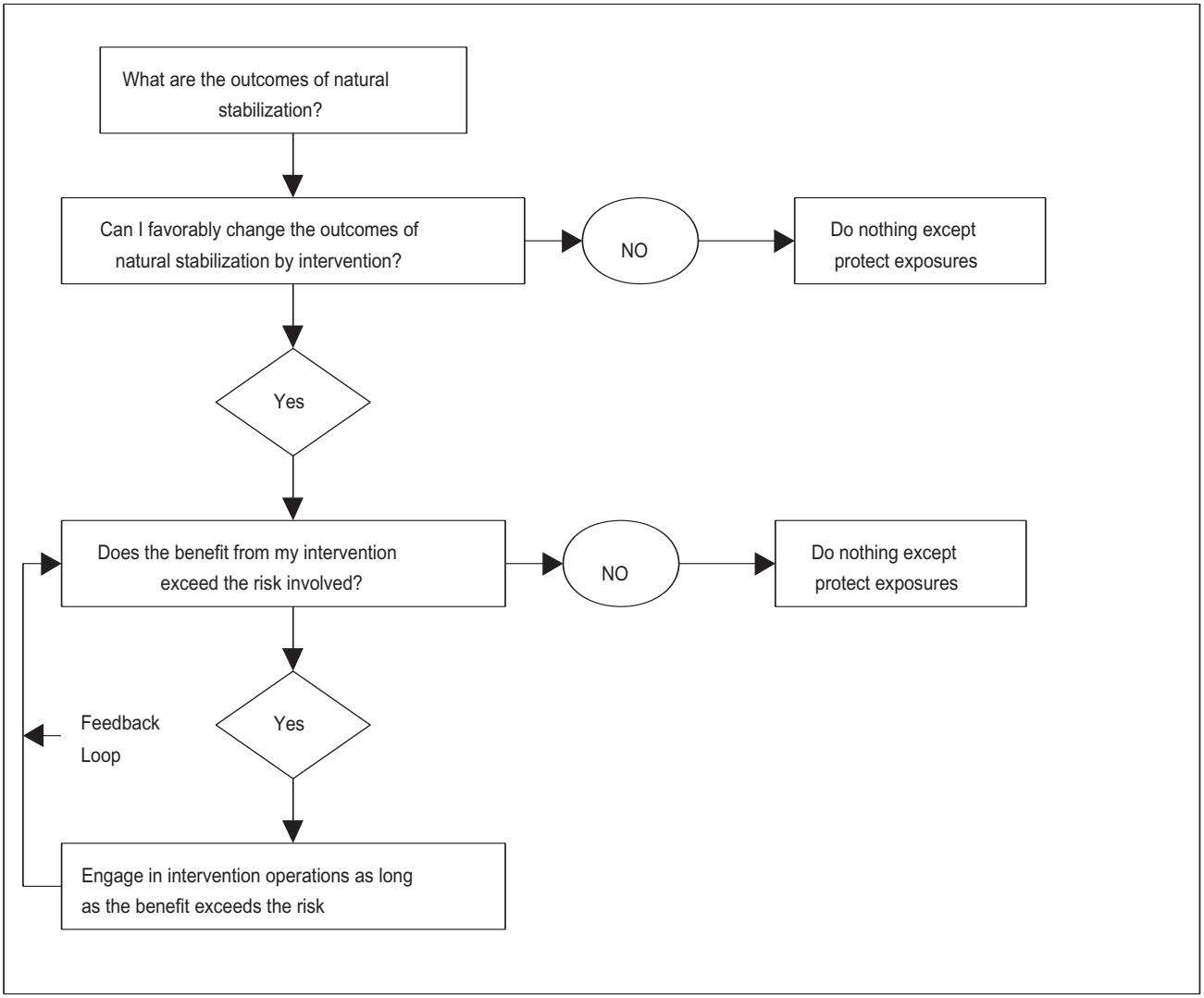
WHAT RESPONSE MODE SHOULD YOU USE?

Does the incident require reconnaissance or rescue? Do you need to evacuate an area? Is confinement and control an appropriate action? Or should you wait for additional help and/or resources?

RISK/BENEFIT ANALYSIS

To this point, this course has been dedicated to teaching you how to determine the hazards and risks that you will eventually face at the scene of a hazardous materials incident. Now, you have to be able to compute those risks against the benefits of proceeding with the operations.

Trading one life for another is not acceptable. In the awareness course and during this course, you have learned that no one is more important than you are. Your safety is first and foremost on every run. Trading your life, because it is a noble or heroic thing to do, is not acceptable. It is also stupid and will probably result in serious injury or death to you. It could also result in unnecessarily endangering the lives of your team or someone else's team. If you and your team can effect a rescue without **an unreasonable** risk to safety, then you should proceed. It is a judgment call, there is very little that can quantify or qualify what an unreasonable risk to safety is in this field. The flowchart below will help you determine the whether to intervene or whether to stand by.



Priorities

There are three things that you must keep in mind as you set your response objectives. You must ensure safety to the responders. You must do things in such a way so that you can maintain control of the various work activities. Finally, you must prevent the spread of contamination.

Written Objectives

It is of the greatest importance that you write down your objectives. Secondly, you must share the objectives with the rest of the response team. If you are the incident manager, you will be responsible for preparing and delivering a briefing to your team. In addition, the incident manager and safety officer should identify under what circumstances the operations will be altered, suspended or terminated (i.e., unsafe operations, unsafe orders, etc.). The incident manager and the safety officer should identify any safety hazards that exist before engaging in defensive operations.

CHAPTER NINE - SPECIALCONSIDERATIONS

TERMINAL OBJECTIVE

By the end of this chapter, you will be able to identify potential hazards associated with terrorism and criminal activities.

ENABLING OBJECTIVES

By the end of this course, to a proficiency of 70%, you will be able to:

1. Identify at least three (3) hazards that could be associated with an inicdent involving criminal or terrorist activity.
2. Given the following types of warfare agents, identify the corresponding DOT hazard class division:
   (a) Nerve agents
   (b) Vesicants (Blister agents)
   (c) Blood agents
   (d) Choking agents
   (e) Irritants (riot control agents)
   (f) Biological agents and toxins
3. Describe possible procedures to preserve evidence at hazardous materials incidents involving suspected criminal or terrorist acts.
4. Identify the type of assistance provided by the federal defense authorities, such as Defense Logistics Agency and the U.S. Army Operations Center, with respect to criminal or terrorist activities involving hazardous materials.
5. Identify the procedure for contacting federal defense authorities as specified in the local emergency operations plan or your organization's SOPs.

INTRODUCTION

One of the hottest phrases in the emergency response field right now is Weapons of Mass Destruction (WMD). Louisville, Lexington, London, Morehead and numerous other communities all over the state have started giving training to emergency response personnel and othe essential personnel concerning this very topic.

In addition to WMD, you should be concerned, perhaps moreso, with clandestine drug manufacturing laboratories. The popular drug is called methamphetatmine, or meth for short. There are a great amount of other names meth is known by, crystal meth, speed etc. You need to know that it is trouble. These meth labs are meant to be hidden. You may find them in the inner city, the back woods and anyplace in between. In June of 2000, there were about 2 or 3 labs being taken by law enforcement task forces every week. Most of these labs were located in the western part of the state. In March of 2001, there are about 2 or 3 taken every day all over the state.

What this amounts to for you is that you must be prepared, not only to deal with the hazardous materials incident, but with a potential crime scene as well. Kentucky has seen its share of terrorism. The KET letter in the late 1990's is the most well-known of the incidents. However, there was a bomb set in front of a Simpson County courthouse in 2000 and various other incidents

throughout the state. You need to be prepared. Therefore, you will get this brief introduction to **B-NICE**; **Biological, Nuclear, Incendiary, Chemical, and Explosives**.

Hazards of Warfare Agents

As a responder to hazardous materials incidents, you understand a certain phraseology. In order to fully understand the threats posed by the agents used in terrorism. However, terrorism is not the only place you will find these. THe Bluegrass Army Depot houses several tons of chemical warfare agent. Below is a table to help you identify the agent type and the associated DOT hazard class.

Warfare Agent	DOT Class	Example
Nerve Agents	Class 6.1 Toxic	Sarin
Vesicants (Blister Agents)	Class 8 Corrosives Secondary Class 6.1 Toxic	Mustard
Blood Agents	Class 6.1 Toxic	Hydrogen Cyanide
Choking Agents	Class 6.1 Toxic	Phosgene
Irritants (riot control agents)	Class 6.1 Toxic	CS
Biological Agents	Class 6.2 Etiologic Agents	Botulin

Scene Preservation

If you suspect criminal activity or an attack, you should treat the incident as a crime scene. Your organization or agency should have clearly identified procedures for addressing these types of incidents. In addition, the local emergency operations plan for your jurisdiction is developing an annex to address the needs of these incidents. Responding to these incidents require partnerships in ways that have never been before. Law enforcement and fire service, public works and emergency management and a host of other agencies need to come together, train together and work together in order to provide a safe, effective and efficient hazardous materials response. If you are a member of the law enforcement community, then you should learn from this training that you cannot effect an appropriate response without the help of other agencies.

Terroist and criminal activites involving hazardous materials require partnerships between all emergency response agencies.

In this course, there is not an adequate amount of time to teach you in the proper techniques of crime scene preservation. You need to work with

your local law enforcement agencies to get training in these techniques. However, a potential crime scene should be cordoned off using ropes, barrier tape or perimeter tape. This is done to eliminate all traffic, both pedestrian and vehicular. This scene will remain closed to all except scene specialists involved in securing evidence.

ASSISTANCE FROM THE DEFENSE LOGISTICS AGENCY OR U.S. ARMY OPERATIONS CENTER.

A valuable asset to you during a terrorist act or an incident involving military shippments of hazardous materials is the Defense Logistics Agency (DLA) or the U.S. Army Operations Center in Washington, D.C.. In the Kentucky Emergency Operations Plan (KyEOP) and most local plans, there are procedures for contacting federal defense authorities.

If you have an incident involving any miliatry shipment of hazardous materials, except ammunition and explosives, you must contact the Defense Logistics Agency (DLA) at (800) 851-8061. For military shipments of explosives or ammunition, call the U.S. Army Operations Center collect at (703) 697-0218.

SECTION FOUR

IDENTIFYING ACTION OPTIONS

CHAPTER TEN – PERSONAL PROTECTIVE EQUIPMENT

TERMINAL LEARNING OBJECTIVE

Given the name of the hazardous material involved and the anticipated type of exposure, the first responder at the operational level shall determine whether available personal protective equipment is appropriate for implementing a defensive option.

ENABLING LEARNING OBJECTIVES

1. Identify the appropriate respiratory protection required for a given defensive option.
2. Identify the three types of respiratory protection and the advantages and limitations presented by the use of each at hazardous materials incidents.
3. Match the function of the operational components of the positive pressure self-contained breathing apparatus provided to the hazardous materials responder with the name of the component.
4. Identify the procedures for cleaning, disinfecting, and inspecting respiratory protective equipment.
5. Identify the procedures for donning, working in, and doffing positive pressure self-contained breathing apparatus.
6. Demonstrate donning, working in, and doffing positive pressure self-contained breathing apparatus.
7. Identify skin contact hazards encountered at hazardous materials incidents.
8. Identify the appropriate personal protective clothing required for a given defensive option.
9. Identify the purpose, advantages, and limitations of the following levels of protective clothing at hazardous materials incidents:
    (a) Structural fire-fighting protective clothing
    (b) High temperature-protective clothing
    (c) Chemical-protective clothing
        1. Liquid splash-protective clothing
        2. Vapor-protective clothing
10. Identify the importance of the buddy system in implementing the planned defensive options.
11. Identify the importance of the backup personnel in implementing the planned defensive options.
12. Identify the safety precautions to be observed when approaching and working at hazardous materials incidents.
13. Identify the physical capabilities required for, and the limitations of, personnel working in the personal protective equipment as provided by the authority having jurisdiction.
14. Identify the required physical capabilities and limitations of personnel working in positive pressure self-contained breathing apparatus.
15. Identify the importance for using the buddy system in implementing the planned defensive options.
16. Identify the importance of the back-up personnel in implementing the planned defensive options.

17. Identify the symptoms of heat and cold stress.

Introduction to Personal Protective Equipment

Personal protective equipment is the most important equipment that you can have. It PROTECTS YOU. Personal protective equipment (PPE) is as important to your response as is the training you are receiving. On a hazardous materials incident scene, you have learned that there are serious threats to your health and physical well being. Whether it is the potential explosion of the flammable liquid or the possible systemic reaction to the toxic substance, there are serious threats to you and your team at a hazardous materials scene.

Not all PPE manufactured is compatible with every substance. As a first responder at the awareness level, your job was to keep yourself and others away from the hazardous materials. At the operations level, you will be providing support to technicians by providing decontamination and containment. Because of this, you stand a greater chance of coming in contact with a substance. To properly protect yourself, you must know how to determine the proper protective equipment to use with a given substance.

In this chapter, you will learn how to do this. You will also learn about the potential dangers of certain types of personal protective equipment. Finally, you will learn how to choose the proper protective equipment for the particular task that you are assigned to do.

There is no doubt; this is one of the most important parts of this class. There are three (3) ways to protect yourself from a hazardous material: time, distance and shielding.

PPE is meant to shield or isolate you from the different forms of harm that may be encountered at an incident scene. As mentioned above, there is not one PPE that can provide a sufficient barrier from all hazards that you may encounter. It is important that you are familiar with the different levels of protection, but also with the considerations and risks involved in choosing, maintaining, wearing and decontaminating the PPE available.

Protecting You

There are three ways of protecting yourself from the potential harm presented by a hazardous material. These three (3) factors, time, distance and shielding should be considered when attempting to influence the rate and degree of exposure. In the next few paragraphs, you will examine these factors.

Time

The longer you are exposed to a material; it is probable that the effects of the exposure will be worse. As an operations level hazardous materials first responder, you must take into consideration the time your teams are exposed during the reconnaissance, rescue, control, or containment. Again, PPE comes with some inherent dangers. These will be discussed later in this chapter. However, when chemical concentrations are relatively low, limited exposure time for a responder that is not wearing any PPE may be the best protective option.

Distance

The farther away you are from the source of harm, the less the concentration available for exposure. Due to this, all personnel who are not directly involved in the operation should be kept at a distance. This is where the use of the staging area is essential to a safe, effective and efficient response. In addition, to staging areas, the proper use of perimeters are the most effective method for applying the principle of distance. You will learn about determining perimeters later in this course.

Shielding

Probably the best known example of shielding is using lead against X-ray exposure. However, shielding is also the protective clothing worn by the responder. In this chapter, you will learn about the use of protective clothing as it applies to the principle of shielding.

In addition, if you are working toward becoming an incident manager, 29 CFR 1910.120 states that you "shall know and understand the hazards and risks associated with employees working in chemical protective clothing."

Respiratory Protection

You have learned that there are several routes for exposure to a hazardous material: ingestion through the digestive tract, injections and absorption through the skin, and inhalation through the respiratory tract. However, it is the respiratory system that is the primary route for chemical exposures in the workplace, including on the emergency scene. Prior to 1970, the use of respiratory protection was advised. Firefighters, among other professions, took pride in not using respiratory equipment, by calling themselves "leather lungs" and other titles. However, in 1970, legislation was created – part of which was 29CFR1910.134, The Respiratory Protection Standard – that established certain requirements for respirator use, testing, and certification. Two federal agencies were tasked with the responsibility of testing and certifying respirators, National Institute of Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

Part of the Respiratory Protection Standard states that the personnel required to wear respiratory protective equipment and the officer or supervisor charged with monitoring the respirator program must have a basic understanding of the selection, operation, fitting, limitations and maintenance of the equipment.

In addition, the standard states that nothing may interfere with the mask-to-face seal of the respirator. This is perhaps the most controversial part of the standard, because it means that beards are not allowed on men who may wear a mask. Long hair, mustaches, and anything else that may not allow a seal of the mask to the wearers face are also not allowed.

Types of Protection

Essentially, there are three (3) types of respiratory protection: air-purifying respirators (APR); supplied-air respirators (SAR); and self-contained breathing apparatus (SCBA). The classification of respiratory protection, known as respirators, depends how the breathable air is supplied to the face piece or hood of the respirator.

Air-purifying respirators (APR)

The APR uses a filter or absorbent material, called a sorbent, to remove airborne contaminants from the breathing air before the air is inhaled. The APR is a lightweight, usually inexpensive respirator. Many models are disposable.

The APR consists of three (3) parts:

Face piece

Filter sorbent cartridge

Exhalation valve

The APR has a few drawbacks. First, the filter may become saturated with particles or other

contaminants through normal use, which may cause breathing difficulties. Second, the APR does not supply oxygen and are not to be used in oxygen-deficient atmospheres.

In order to use an APR, there must be at least 19.5% oxygen and the contaminant must be positively identified. Constant monitoring of the atmosphere to identify the contaminant, the contaminant concentration, and the oxygen content is required before and during the use of an APR.

You should not use the APR as protection against gases or vapors with poor warning qualities. You need to be able to detect the gas by odor, taste, or irritation before the chemical breaks through the filter. You cannot, must not use the APR in atmospheres where high chemical concentrations may cause immediate or delayed health effects or death. These atmospheres are called Immediately Dangerous to Life or Health (IDLH).

It is strongly recommended that APRs not be used in the initial phases of a response due to the limitations mentioned above.

Supplied-Air Respirators (SAR)

SARs get their name from the fact that air, never pure oxygen, is supplied to the wearer from some source. SARs may be used with or without a fully encapsulating suit. There are several pieces to the SAR.

Face piece

Breathing tube

Escape bottle

Regulator

Air supply tube

Remote air supply

Exhalation valve

The SAR can be used as protection against all particles or gases, and can be used in oxygen deficient atmospheres. These may be used for extended periods of time because they use large air supplies. These are lighter than self-contained breathing apparatus (SCBA) and are sometimes cooler than APR. This may allow longer periods of work because of the lessened physical stress on the wearer.

The SAR is limited because there is a 300-foot maximum allowable hose length provided the regulator is worn by the wearer. However, if the regulator is separated from the wearer, then the hose length is only 75 feet.

Another limitation to the SAR is that the path to enter and exit must be the same. The hose line, which supplies air to the wearer, is not required to be tested for chemical compatibility against anything except gasoline. Therefore, it may be compromised and lead to contamination of the wearer's air supply. When working in an IDLH atmosphere, responders must carry an "escape bottle" in case of a SAR failure.

SAR's require continual monitoring and maintenance to maintain the required pressure and flow rate.

Self-Contained Breathing Apparatus (SCBA)

The SCBA is probably the most popular respirator used in Kentucky. All fire departments have SCBAs and so do many rescue squads. The State Police Special Response Team and many municipal law enforcement task forces have invested in these respirators as well.

The SCBA is a breathing apparatus that uses a source of breathable air that is carried by the wearer. This greatly enhances the mobility of the wearer, while limiting the duration of respiratory protection. Most of the SCBAs use 30-minute air supply bottles, although there are 60-minute air supply bottles in use by many departments in Kentucky.

The SCBA has several parts:

Air cylinder and valve

Air supply tube

Regulator

Breathing tube

Face piece

Exhalation valve.

Because it is self-contained, the SCBA provides the highest level of respiratory protection available. There is greater mobility because the length of hose or the restricted routes do not restrict the wearer. The duration of work is limited; however, this becomes a positive because it allows for more frequent rotation of hot zone personnel, reducing the potential for heat stress injuries.

The limitations of the SCBA are really the amount of physical stress placed on the wearer. The SCBA weighs up to 35 pounds and may increase the workload up to 20%. In addition, the limited duration of the air supply results in a limited amount of work by the wearer.

There are two types of SCBA, open circuit and closed circuit. The open circuit SCBA is the most popular. It is called an open circuit because it allows the exhaled air to be discharged directly to the outside atmosphere.

In closed circuit SCBA, or rebreather, the exhaled air is recycled, usually through a chemical scrubber. The oxygen is replaced with either liquid oxygen, gaseous oxygen, or by some oxygen-generating chemical.

The closed circuit SCBA has certain advantages over the open circuit. First, it is usually lighter. The closed circuit SCBAs may also have a longer operational duration, with some ranging up to two hours. However, the closed circuit SCBA requires that you must carry a hazardous material on your back, or sometimes front. If the apparatus should fail, then you would be at greater risk of injury due to the presence of an oxidizer. In addition, the chemical scrubber creates heat. This heat, especially inside of chemical protective clothing, can produce more stress on the wearer.

Selecting the Proper Respirator

In Kentucky, the best choice is the SCBA. However, there are applications for the APR and SAR. It is not recommended to use the APR until after the chemical has been identified and after continuous monitoring has been established and safe air levels have been verified. SARs have limited application under certain conditions.

If you decide to use an APR, you must read the documentation that accompanies both the face piece and the filter to ensure compatibility and effectiveness with the identified chemicals.

Physical Requirements of the Wearer

The use of a respirator, whether it is an APR or a SCBA, places some degree of strain on the wearer, especially the cardiovascular system. In addition, some people are claustrophobic and cannot wear respirators. Therefore, OSHA requires that anyone assigned a task requiring the use of respirators be examined and certified as being able to safely wear the respirator. Ina addition, it is important that a physician review the record of anyone before he or she is assigned to a task that may require him or her to wear a respirator. The physician should be informed of the particulars of the work and type of respirator. In turn, the doctor will provide a written notice stating the fitness for duty of the individual. Any person required to wear a respirator is also required to have the respirator fitted to them to ensure the proper size and that the wearer gets a proper face-to-mask seal.

Care of the Respirator

It is extremely important to take proper care of your respirator. This includes washing and sanitizing the respirator. Respirators that are not properly maintained will provide a reduced amount of protection to the wearer. Due to the variety of makes and models of the respirators that are in use, it is best to follow the manufacturer's guidelines for the proper care of your equipment.

Protective Clothing

Your body is the most valuable possession you have. In order to shield it from the hazards of the hazardous materials present. There are three (3) general categories of protective clothing: structural firefighting, high-temperature, and chemical.

Structural Firefighting Protective Clothing

Structural firefighting protective clothing, also known as bunker gear or turnouts, is designed to protect the wearer from extremes of temperature, steam, hot water, hot particles and the hazards of structural fires when worn properly.

This equipment usually consists of rubber boots with a steel toe and shank to protect the feet. There are pants with a thermal/vapor barrier to protect the wearer from steam. There is a coat with the same type of protection as the pants. In addition, there is a protective hood. The pants, coat and protective hood are all treated with flame resistant materials. There is a helmet with a face piece to protect the head and eyes from debris. There are leather gloves use to protect the hands. Finally, an SCBA makes the equipment complete.

This equipment is intended to protect the wearer from temperatures encountered in structural firefighting.

This type of PPE is the most common specialized protective equipment used on a hazardous material incident. However, IT IS NOT DESIGNED TO NOR DOES IT PROVIDE ADEQUATE PROTECTION AGAINST CHEMICAL PERMEATION OR DEGRADATION.

It may offer limited protection against solid materials and some liquids. However, this type of protective clothing offers no protection against vapors or gases. The construction and the porosity

of the outer shell of the garment make decontamination difficult. Therefore, this should not be worn in areas where protection against chemical splashes or permeation is required.

High-Temperature Protective Clothing

Also known as proximity suits or fire entry suits, these are designed to protect the wearer from radiant heat temperatures as high as 2000° F. These suits are usually a one or two piece overgarment with a hood, gloves, and occasionally boot covers made of an aluminized nylon or cotton fabric.

These garments offer little, if any protection against chemical permeation or degradation. When these are used in conjunction with fully encapsulated chemical suits, both an SCBA and auxiliary cooling are required.

Chemical Protective Equipment

Chemical protective clothing is designed to protect the wearer from chemical contact with the skin or eyes. Chemical-specific compatibility, lack of thermal protection, and the ability to be reusable or disposable characterize its construction. If it is reusable, it means that the garment can be decontaminated and reused. Chemical protective clothing is divided into encapsulating and non-encapsulating suits.

These suits may be constructed from several different types of fabrics/materials. Neoprene, polyvinyl chloride (PVC), chlorinated polyethylene (CPE), butyl, nitrile, viton, Teflon™ /fiberglass, or Teflon™/Kevlar™. Other suits may be made of spun fibers such as Saranex™ or Tyvek™, however, these provide limited protection against hazardous liquid or vapor substances. These substances will protect against dusts, particles, and other nuisances. The disposable garments may be used as an outer covering over the primary protective clothing. This may limit the amount of direct contamination of the primary gear and makes gross decontamination easier.

Chemical Compatibility

There is no type of chemical protective clothing is compatible with all chemicals you may encounter. Here are a few examples of incompatibilities.

Polyvinyl alcohol may work well against chlorinated hydrocarbons and petroleum compounds, however it is soluble in water – including your perspiration.

Neoprene resists acids and many chemicals. However, it reacts with strong oxidizing acids and aromatic hydrocarbons.

Viton reacts with ketones and nitro-containing compounds.

Duct tape, used around the ankles, wrists, zippers and respirator face pieces is incompatible with oxidizers and undergoes a violent chemical reaction.

Regardless of the material of construction, all protective clothing and equipment is limited to a known performance range. You must always consult the manufacturer's compatibility charts when you select the proper type of chemical protective clothing and equipment.

In addition to the manufacturer's charts, the National Institute of Occupational Safety and Health publishes the "Recommendations for Chemical Protective Clothing."

Chemical Resistance

There are three terms that should strike fear in your heart when you think of chemical protective clothing: permeation, penetration, and degradation. These three words are how the chemicals can get to you while you are in the suit.

Permeation

This term describes a chemical's ability to actually work its way through the fabric on a molecular level. Different fabrics have different resistance to chemical permeation and all will absorb chemicals, albeit at widely different rates.

Penetration

This describes the garment's ability to prevent leakage through the garment at voids such as button holes, zippers, and stitch holes. Many times glue or sealed seams are used to prevent penetration through needle holes. Some garments also have over-flaps on zipper or button openings. These flaps help to prevent leak-through.

A common practice used to reduce penetration in the field is to seal exposed seams, such as those around gloves and boots using tape. Remember the warning about the reactivity of duct tape, use velcro straps.

WARNING – IF YOU ARE TAPING AROUND A FACEPIECE OF A RESPIRATOR TO PREVENT THE ENTRY OF A HAZARDOUS MATERIAL THEN YOU ARE USING THE WRONG LEVEL OF PROTECTION.

Either upgrade to a higher level of protection or examine your work practices. It is important to remember to secure the sleeves and pant legs **over** gloves and boots to prevent liquids from draining into boots or gloves.

Degradation

This refers to a chemical's ability to break down or destroy fabric. Some chemicals may dissolve the fabric cause it to turn brittle, swell, crack or otherwise fail. This is referred to as degradation. Ultraviolet light can cause this as well as moisture and even normal wear and tear may cause this. Degradation is a visible process as opposed to permeation or penetration. This is why inspecting and testing protective clothing by competent personnel is essential.

Fully Encapsulating Suit

Types of Chemical Protective Clothing – Fully-Encapsulating, Non-encapsulating, and Aprons

Fully-encapsulating suits are one piece garment that provide chemical protection for the entire body. Boots and gloves may be an integrated parts of the suit, attached yet replaceable, or separate. These suits require a SCBA or SAR and are intended to create a microenvironment.

Non-encapsulating suits usually consist of a jacket and hood in combination with a pair of pants or bib overalls. They are constructed of a variety of materials. These suits can provide excellent protection against splashes, dust and other materials that cannot migrate between the various layers. When these suits are worn in the field the connection between the overlaps are sealed. Again, this should be done with something other than tape, such as an adjustable band that adheres to itself or a velcro

strap.

Aprons are used for many operations such as sampling, labeling, or analysis. This is because the primary areas of concern for exposure are the chest and forearms. A sleeved apron, when worn with disposable gloves or worn with overgloves, can be useful in certain situations.

The Buddy System

Using the buddy system is important for your safety and that of your team. Using this will prevent or at least minimize unnecessary injuries and contamination. This will ensure that proper and safe work practices are implemented. It makes certain that a responder will come out of the scene, have communications, and have aid rendered quickly in the time of an accident.

The buddy system should be practiced to ensure that the buddy provides his or her partner with proper assistance; is an extra set of eyes and ears for his or her partner; and observes his or her partner for signs of stress or exposure. Finally, the buddy will notify others if his or her buddy goes down.

Back-Up Personnel

Besides the buddy system, a backup team is a good method of protection for the defensive entry team. Beside, it is required by law. A back up team is extremely important because it provides additional personnel that are already in the proper level of protective clothing and on a breathing apparatus in the ready. If the entry personnel should have a problem or need assistance, the back up team is ready to assist or remove the primary team, such as in the event of an escalation of the incident.

Hazards of Using Protective Clothing

While protective clothing provides you with a great deal of protection from the hazards of a hazardous material, it does present some problems.

Heat and cold related illnesses

One of the benefits of chemical protective clothing is the fact that, when donned properly, it creates a microenvironment. This means that vapors and liquids are not allowed to get in to the wearer. It also means that vapor and liquids are not allowed to escape into the environment. This presents a problem because it may inhibit the body's natural cooling process. This puts great stress on the body. Heat related illnesses may include heat rash, heat cramps, heat stress, heat exhaustion, and heat stroke. Of these, heat exhaustion and heat stroke present the most danger.

The signs and symptoms of **heat exhaustion** are:

Profuse sweating
Pale and clammy skin
Weak pulse
Rapid, shallow breathing
General weakness
Dizziness

If left untreated, heat exhaustion can rapidly progress into heat stroke. Heat stroke is a serious medical emergency and requires immediate medical attention.

The signs and symptoms of **heat stroke** are:

Dry, hot and flushed skin

Dilated pupils
Full and fast pulse becoming rapid and weak as cell damage occurs
Deep respirations that eventually become shallow.
Muscular twitching and/or convulsions
High body core temperature

Cold related illness is a problem, especially in cold environments. Many times, responders will anticipate heavy workloads and fail to wear adequate undergarments. In addition, unheated water used for decontamination may contribute to this problem. Cold related illnesses might include frostbite and hypothermia.

The signs and symptoms of **hypothermia** are:

Intense or uncontrollable shivering
Difficulty in speaking
Muscular rigidity
Confusion or delirium
Slowed pulse and respiration

Decreased Agility

Decreased agility is a serious concern on many operations. When you wear protective equipment. The steps on rail cars and tanks trucks are small. You should ensure that you have a firm foothold before you apply all of your weight.

The gloves inhibit tasks requiring dexterity. Therefore, tools may fall out of your hand and keying your radio may be impossible. This is why you should have tools that have easy-to-grasp handles and radios with hands-free operation.

Speaking of tools and radios, you should make certain your tools are compatible with the materials you are handling and that your radios are **intrinsically safe**.

Finally, the equipment you are wearing will change your center of balance, especially when you are wearing an SCBA. The only thing that will help you keep you safe and injury free is regular practice in the equipment you will use on scene, before you arrive on scene.

Decreased Vision

Wearing personal protective equipment often requires that you wear eye protection, sometimes several layers of eye protection. This means that your vision may be distorted. In addition, your field of vision may be decreased. This creates a serious hazard in and of itself; however, when you are working around a crash scene or around heavy equipment, then the risk is greatly increased. You must take special care to be aware of your surroundings, including the movement ranges of equipment.

Decreased Hearing

Hoods, breathing apparatus, and hearing protection can seriously decrease your hearing ability. This complicates communication between you and your team as well as your ability to hear leaking gases or other clues of a hazard.

Claustrophobia

This is a true medical condition and may occur in individuals who have worn fully encapsulated suits before. Responders who have suffered from claustrophobia should not be assigned to tasks requiring them to wear this type of equipment. Again, practicing with your response

equipment is essential. It is better to identify this condition in practice, than in the field.

Lack of Thermal Protection

Chemical protective suits are not known for the warmth they provide. In fact, they provide no protection from heat and limited protection from the cold. Most suits will fail in less than five (5) seconds under fire conditions.

Maintenance

Chemical protective clothing requires an inspection and maintenance program to ensure your safety and the safety of your team. Tears or defect must be repaired or the garment must be replaced. Failure to do the inspections and maintenance may result in an exposure to a material that could have been prevented.

Levels of Protection

The United States Environmental Protection Agency has identified four levels of protection are used during a response to a hazardous materials incident. It is imperative that you understand these levels and when to use them.

The designations for these levels are A, B, C, and D. The level of protection that you use will depend on the type of work being performed and the working conditions. Level A provides the highest level of protection while level D provides the lowest level of protection.

Level D

This level of protection is used when special respiratory or skin protection is not necessary. Essentially, this is a work uniform that provides only minimal protection. Level D protection may be used only when the work required can rule out the possibilities of splashes, immersion, or unexpected inhalation.

Level D involves coveralls, chemical-resistant steel toe and shank. This may sound familiar to you, since these are the primary components of structural firefighting personal protective equipment. STRUCTURAL FIREFIGHTING PERSONAL PROTECTIVE EQUIPMENT ONLY PROVIDES LEVEL D – THE LOWEST LEVEL OF CHEMICAL PROTECTION.

Level C

This level of personal protective equipment does not require maximum skin or respiratory protection. This is the only level where the use of an APR is acceptable. Level C protection may be used when atmospheric contaminants, liquid splashes or other direct contact with a substance will not adversely affect or be absorbed by any exposed skin.

When you are using level C, you must be certain that the types of airborne contaminants have been identified, concentrations have been measured, the atmosphere has at least 19.5% oxygen, and the APR is approved and compatible to remove the contaminants.

Level C protection consists of a NIOSH-approved compatible air purifying respirator (APR) and hooded chemical resistant clothing. Chemical resistant inner and outer gloves are required as well as outer boots with a steel toe and shank.

Level B

Level B is used when the highest level of respiratory protection is required, but a lesser degree of skin protection is required. This is the minimum level recommended for initial site entry when the substance and concentrations are unknown.

This level consists of an NIOSH-approved positive pressure SCBA or positive pressure SAR with an escape SCBA. A non-encapsulating chemical suit compatible with the substance is also required. The suit must be one or two piece with a hood. Inner and outer gloves are also required as well as chemically resistant outer boots with steel toe and shank. An intrinsically safe two-way radio communications are also part of the PPE.

Level A

This is the HIGHEST LEVEL OF PROTECTION AGAINST CHEMICALS. This level provides the greatest level of skin, eye, and respiratory protection. This is required when responders must enter an IDLH (Immediately Dangerous to Life and Health) environment.

Level A consists of an NIOSH-approved full-face piece SCBA – or a positive pressure SAR with an escape SCBA – and a fully encapsulating chemical suit. In addition, this level requires chemical resistant inner and outer gloves and outer boots. The boots must have steel toes and shank. As with the level B, an intrinsically safe two-way radio communications are required.

Military Personal Protective Clothing.

Military Offensive Protective Posture equipment or MOPP gear is the military's version of chemical protective clothing. Many of these resemble the EPA levels of Chemical protection. Some, such as charcoal impregnated two-piece, hooded suits are unique to the military. However, MOPP gear is not recognized outside of the military.

Many Kentucky responders have attended training at the Chemical, Ordinance, Biological, and Radiological (COBRA) training center located at Ft. McClellan in Anniston, Alabama. During a portion of this training, trainees are required to dress in MOPP gear consisting of an APR, protective over-boots, and charcoal impregnated suits.

This PPE is commercially available and may be found in many military surplus stores. However, this is not recognized as proper PPE and **should not be used** until the EPA, the Kentucky Labor Cabinet's Occupational Safety and Health Department, and other regulatory agencies, approve it.

Wearing and Using PPE

PPE is an important response tool. However, it takes a great deal of training to select and wear the proper PPE. It is essential to your safety to practice with the PPE available to you and your team. Because of the variety of PPE used in Kentucky, this course cannot provide adequate instruction in using this equipment.

However, here are a few recommendations for selecting PPE. Chemical protective clothing is expensive. It is not feasible for a response team to stock chemical protective clothing for every potential chemical. Therefore, prior to selecting PPE for your team, you should evaluate the most predominant chemicals in your jurisdiction and choose the equipment appropriate for those chemicals.

Secondly, close does not count. If you do not have the appropriate equipment, do not go. In addition, if you are not trained to use the equipment, do not go. You are placing your life and the lives of your team members in jeopardy if you go.

Finally, just because a piece of protective clothing is expensive does not mean it is the best for your application. For the majority of hazardous materials response teams in Kentucky, the SCBA is the source of respiratory protection. Earlier you learned that the air supply lasts up to one hour. This requires that you undergo decontamination, which requires the removal of your suit, at least

partially every hour. Therefore, disposable suits with shorter exposure times may be a better investment instead of more expensive suits with longer exposure times that may require extensive documentation and maintenance after use.

When using and choosing any suit, be certain to use the manufacturer's documentation for the proper use of the garments.

In conclusion…

You have the potential to be exposed to a wide-variety of chemical forms and compositions. The primary line of defense to preventing an exposure and the resulting adverse health effects is the proper selection, use, cleaning, maintenance, testing and storage of personal protective equipment.

Chapter Eleven – Decontamination

Terminal learning Objective

The first responder at the operational level shall identify emergency decontamination procedures.

Enabling Learning Objectives

1) Identify ways personnel, personal protective equipment, apparatus, and tools and equipment become contaminated.
2) Describe how the potential for secondary contamination determines the need for emergency decontamination procedures.
3) Identify the purpose of emergency decontamination procedures at hazardous materials incidents.
4) Identify the considerations associated with locating emergency decontamination areas.
5) Identify the advantages and limitations of emergency decontamination procedures.
6) Identify emergency decontamination procedures.

Introduction to Decontamination

You are probably asking yourself, "Why did they put decontamination here?" The answer is simple... Decontamination, or decon is the first action option you must implement. Decon is the primary safety net should you or your team become exposed to a hazardous material during a response.

In chapter 3, you learned that contamination was a process. Decontamination is also a process. It is the process of physically removing the contaminant from you or changing the chemical properties to less harmful substances.

Once command has been established and you have chosen protective clothing, control activities will begin. The first control activity that you should consider is decon. If you do not have enough people to take care of decontamination, then you certainly will not have enough people to take care of other control activities. Decontamination is a primary means to stopping the spread of contamination.

Failure to properly establish and execute decontamination could cause you or your team serious damage to your health or worse. In the Hazardous Materials Annex of your local emergency operations plan or in your department's general operating guidelines, there should be procedures for establishing the proper decontamination procedures.

If you are sending patients to a healthcare facility, you must give that facility prior notification to allow them to prepare their facility. This may include draping equipment, removal of non-essential equipment and people. It may be a viable option to use the hospital's morgue to treat contaminated patients because of the ease of decontaminating the room after use.

As an EMT, paramedic or emergency department personnel, decontamination of patients should

how blood and other bodily fluids, both seen and unseen, can cause other patients to become infected if you do not properly clean and disinfect your ambulance or emergency room. The same principle holds true with persons who have been exposed to a hazardous material. If you do not properly decontaminate them, then you can spread the contaminants outside of the hot zone, into your ambulance and into an emergency room full of sick and injured people.

CONTAMINATION

You have learned that contamination is a process of transferring a hazardous material from its source to people, animals, the environment, or equipment, which may act as a carrier. However, do you know how it occurs?

Contamination may occur in a variety of ways, including coming in direct contact with vapors, gases, mists or particulate matter in the air. The material might splash you. Walking or driving through puddles of the substance or on contaminated soil are also ways of being contaminated. Finally, using contaminated instruments, equipment or clothing will also allow you to become contaminated.

You wear PPE to prevent you from being contaminated. You are learning to establish solid work practices that will help reduce contamination on your PPE and instruments. However, even with these things in place, contamination may spread.

In adequate decon procedures can allow contamination to spread out of the hot zone. Unprotected personnel may then be exposed to the hazardous substance through this secondary contamination.

To prevent this from happening, controls to avoid becoming contaminated, minimize contamination while decontamination procedures must be developed and established BEFORE anyone enters the site.

In this course you will learn about emergency decontamination procedures, which is used for unexpected contamination and contamination of those not wearing protective clothing. You will also learn about how to properly decontaminated those who are wearing PPE.

The National Fire Protection Association or the Occupational Safety and Health Administration does not have a specific decontamination procedure. Each procedure is left up to the local jurisdictions. There are not many reference materials that actually give systematic decontamination procedures. The intention of this course is to present you with a model that you can follow. However, it is best that you develop a procedure that best fits your team. Regardless, it is imperative that you develop a written decontamination procedure and exercise it before you make a response.

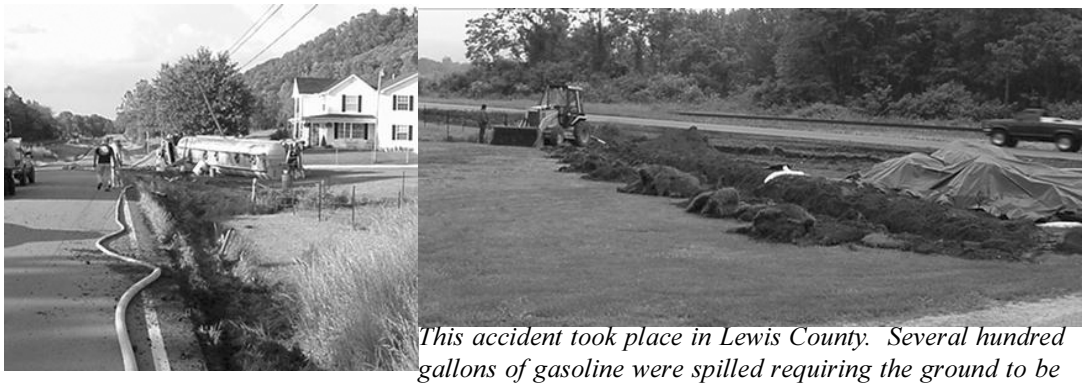
Decontamination Agents

There are several techniques to use for decontamination. However, you must always identify the chemicals involved. This is very important because the chemical will dictate what substances you are able to use as a decontamination agent. For example, if you had persons exposed to sulfur dioxide gas and used water to decontaminate them, you would create sulfuric acid on the person's skin and cause serious chemical burns to that person. In many instances, MSDSs will provide agents to use for decontamination. In addition, you may **call the Kentucky Regional Poison Center at (800) 722-5725**. They have information concerning how to decontaminate persons after exposure. You must give them the name of the chemical(s) involved and they can give decontamination information as well as emergency treatment recommendations.

Decon Runoff

One of your concerns with a hazardous materials incident is damage, potential damage to the environment. Therefore, you must be concerned with where the runoff from decontamination operations will go. You are responsible for disposing the runoff. In addition, some materials cannot be decontaminated. This requires proper disposal of the materials.

For example, in Lewis County a DOT-406 loaded with gasoline rolled on its side releasing several



This accident took place in Lewis County. Several hundred gallons of gasoline were spilled requiring the ground to be dug up and incinerated.

hundred gallons of product on the ground. Consequently, several thousand cubic feet of earth had to be removed, incinerated and buried. In another incident, several pieces of firefighting equipment had to be dismantled and buried.

Kentucky state law required that if anything threatens a waterway or the water table in the state, the Environmental Response Team of the Natural Resources and Environmental Protection cabinet be notified at (800) 928-2380. In addition, to request state level resources, including the State Fire Marshal for Hazardous Materials, you should call the Kentucky Division of Emergency Management's 24-hour call center at (800) 255-2587.

Physical Removal of Contaminants

Decontamination also called contamination reduction can be accomplished by using water, the removal of clothing, using vacuums or pressurized air, and absorption are all ways to physically remove the contaminants.

Water

Water is the most popular method of removing contaminants. However, you must be aware that using water, as mentioned above, can cause certain chemicals to react. Water may also be a carrier for some solid materials into the body. In addition, water may cause other problems such as hypothermia. However, water may be the best option during an emergency decontamination of a non-ambulatory victim.

When you have to perform emergency decontamination, most likely you will use fire hoses. It is best to use small diameter hoses with a 30/30 technique. That is 30 pounds per square inch of pressure coupled with a 30° fog pattern. This will prevent injuries. If you have a large number of people to decon, it may be necessary to use master streams or large streams.

Removing Clothing

Removing contaminated clothing from a victim is often an effective method of decontamination. However, like water, it does have problems. Exposure to weather may complicate the rescue or response effort. People may also resist removing their clothes in public view. In addition, you will have to decide whether clothing should be removed prior to or after decontaminating the clothing.

Pre-Decontamination Considerations

1 You must first assign a **decontamination officer**. This person will oversee the decontamination operations. It may be in the best interest of the decon operations to assign the decon officer from a local fire department. The decon officer's responsibilities are to establish the decontamination corridor; identify the specific required equipment for decontamination, supervising the overall process from outside the decontamination corridor, ensuring the containment for the water used for decon, establishing decon safety levels.

2 Establish the decontamination corridor is the next consideration. You must remember that when you arrive on a hazardous materials scene to find persons who have been contaminated, the appropriate action is to don the proper personal protective equipment and conduct decon immediately without setting up any type of formal decon area. After all, your priorities are life first, then the environment, then property. However, when it is possible, set up your decontamination corridor.

When you establish the decontamination corridor, you should look for an area that is level, upwind and up hill from the incident. If possible, you should choose an area that would allow any decon water that may escape to flow back into the hot zone.

There are many opinions about where to establish the decon corridor in relation to the spill. Generally speaking, establish your decon area no less than 100 feet from the spill at a small incident or 500 feet from the spill at a large incident.

The perimeters of the decontamination zone must be clearly marked. Scene tape, saw horses, or flags are good markers. The decontamination area must also be secure to provide a controlled access point from the hot zone and into the cold zone.

Supplying the decontamination corridor is very important. This means ensuring that the corridor has all of the necessary supplies, equipment, and personnel. It is the duty of the decon officer to ensure this is done. You must make certain that the ground is protected in the decon corridor. Lay down plastic sheeting and roll the edges up to make about a 6-inch border. Using dirt, pike poles, or a pre made wood frame to establish the edges will make a nice catch basin. Make certain that the material you use to line the ground is thick enough to withstand the wear and tear of having people walking on it.

The equipment to be used is important in the safe, efficient and effective decontamination of personnel. Ladders, hoses, and water in good working order are as important as the procedure itself. You should be creative in developing your decon equipment. A portable shower made from PVC pipe and a shower curtain and canvas basin may be helpful in accomplishing not only the decontamination, but also preserving the privacy of those being decon'd. Other equipment that should be in the decon corridor are:

Spare SCBA equipment and bottles
Disposable paper blankets and footwear for persons to wear after being decontaminated.

Shovels
Long spineboards and ladders to use to support them for decontaminating non-ambulatory or unconscious victims.
Chairs
Barrels to put contaminated equipment and clothing in.

Containment of the water used for decontamination is also a concern you must address. The most common device used for this is a children's inflatable wading pool, while others use the preformed pools. A more economical and easier to maintain and store option is a cardboard box lined with double thickness trash bags or plastic sheeting. You can also use a portable sump made out of salvage covers or portable dump tanks to hold the runoff.

Finally, before you make the first run, before you set up the first decon corridor, you must have a set of general operating guidelines. These may not seem important, but should the incident you are on go to court, following established and tested guidelines may prevent you from a substantial fines or worse.

Decon Priorities

When you are called to a hazardous materials scene, there are priorities you must have – people, environment, and property. You must protect you team first, specifically the decon team. The only reason to delay decontaminating patients is to have the decontamination team dress in the proper PPE.

Before patients can be released to emergency medical personnel, they must be decontaminated. If contaminated patients are conscious and coherent, you may be able to instruct them to help expedite the decon process.

Finally, decontamination takes place over modesty and weather exposure. Although undressing someone completely on January 29th on US 27 in Somerset may be cold and embarrassing, it is necessary of decon needs to occur. Use salvage covers for protection from wind and prying eyes, including those of the press. It is possible to use cavitation in the fire pumps to heat the water used for decon. Advanced planning may designate special locations such as car washes, fire stations, and morgues that can be used for decontamination in your community.

Types of Decon

There are two types of decontamination, chemical specific and non-specific. You will determine which one to use based on whether or not you are able to identify the contaminant. When the exact material is identified. If you are unable to identify the material, you will use non-specific, or field decontamination.

There are several levels of field decontamination. The degree of exposure or amount of contact with any gas, vapor, liquid, smoke, dust, or powder determines the levels.

Level 1 Field Decon

This is the lowest level of decon. It is used when you cannot confirm, but suspect that a person has been contaminated.

To accomplish Level 1 decontamination you need to:

Position the person where runoff will be contained. Keep the pressure low to prevent injury to those being decontaminated and unnecessary splashing.

Flush for one minute with a light fog spray. Direct the spray downward to prevent splashing.

Move the person and remove the protective clothing. Move the person away from the initial flushing area and remove the protective clothing and breathing apparatus. The breathing apparatus should be removed after the initial flush; however, leave the respirator flash piece last.

Level 2 Field Decon

This is when you can see that a person has been contaminated, but the skin has not been exposed or irritated by the chemical.

To accomplish Level 2 decontamination you need to:

Position the person where runoff will be contained. Keep the pressure low to prevent injury to those being decontaminated and unnecessary splashing.

Flush for one minute with a light fog spray. Direct the spray downward to prevent splashing.

Move the person and remove the protective clothing. Move the person away from the initial flushing area and remove the protective clothing and breathing apparatus. The breathing apparatus should be removed after the initial flush; however, leave the respirator flash piece last.

Move the person and remove all clothing. Remember plan for modesty protection.

Cover the person and transport the person to a shower. Soap and water is a must follow-up to field decontamination. It is strongly suggested to use moderately cold water first and then slowly increase the temperature. This opens to pores and will allow the materials to be released. Do not allow the shower doors to close; this will allow vapors to escape, preventing possible inhalation exposure.

Level 3 Field Decon

Level 3 decontamination is the highest level of field decontamination. It is used whenever chemicals come in direct contact with the skin or when the chemical has irritated the skin. The primary objective of this level is to rapidly dilute the material and rapidly remove the clothing while undergoing a continuous rinse.

Position the person where runoff will be contained. Keep the pressure low to prevent injury to those being decontaminated and unnecessary splashing.

Flush while removing all clothing leaving the respirator face piece on and connected to the air supply. Direct the spray downward to prevent splashing.

Continue to flush after removing the clothing for one minute.

Remove the respirator face piece and turn off the air supply.

Move the person away from the contamination.

Flush the victim for a minimum of 15 minutes. Be certain to keep accurate track of this time.

Move and clothe the person.

Transport to a medical facility. Transporting personnel to the medical facility is important

for any person who experiences skin contact or respiratory exposure. If you are transporting a victim to a medical treatment facility, you should give them warning that you are in route with a decontaminated patient.

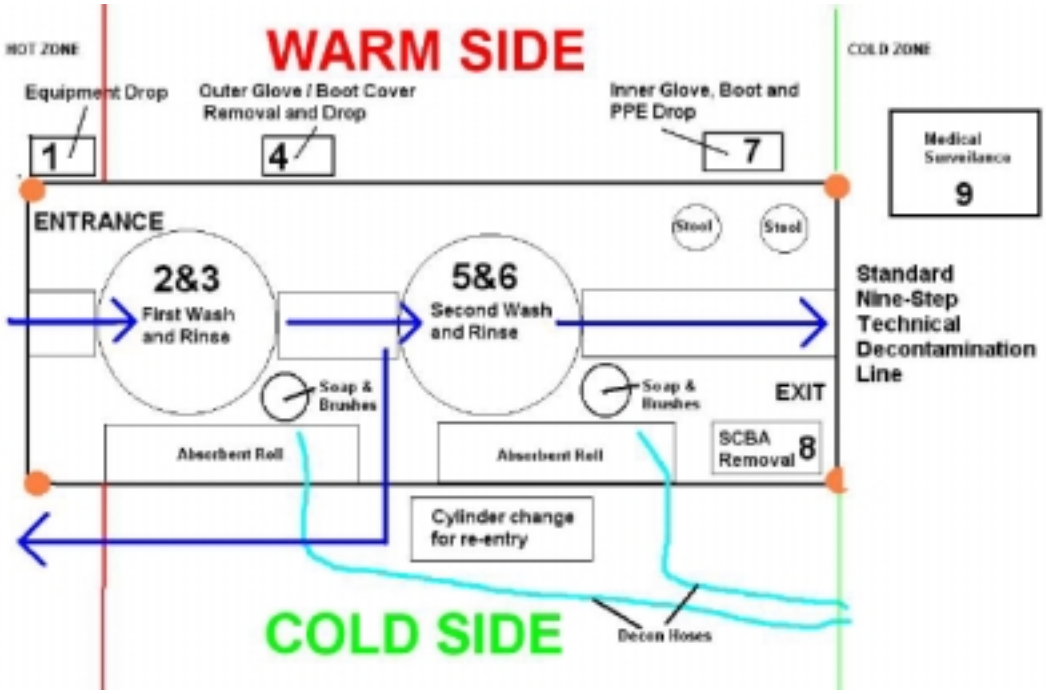
Once you have decontaminated the victims, you must decon the decon team and the decon area. For the team, decon must be done equal to their level of exposure. If a member of the decontamination team experiences skin contact or irritation, the adequacy of PPE should be examined and probably increased.

The next figure illustrates one configuration of the decontamination corridor. Again, there is not an absolute way to establish a decontamination corridor.

Decon of Equipment and Clothing

Specific procedures for decontaminating equipment, vehicles and clothing will depend on the materials involved. This type of decontamination can be expensive and time consuming. Before beginning decontamination of clothing and vehicles, you should consult with the manufacturer of the chemicals involved for assistance. Major apparatus and equipment decontamination required t assistance and coordination with outside companies.

Also, keep in mind that anything made out of porous materials such as leather cannot be decontaminated and must be disposed of. Any personal items taken into the hot zone may remain in the decon area for disposal. This is why all pockets should be emptied before donning protective clothing or entering the hot zone.



Chapter Twelve – Defensive Control Options

Terminal learning Objective

Given simulated facility and transportation hazardous materials problems, the first responder at the operational level shall identify the defensive options for each response objective.

Enabling Learning Objectives

1. Identify the defensive options to accomplish a given response objective.
2. Identify the procedures for establishing scene control through control zones.
3. Identify the criteria for determining the locations of the control zones at hazardous materials incidents.
4. Identify the basic techniques for the following protective actions at hazardous materials incidents:

(a) Evacuation
(b) Sheltering in-place protection

5. Identify the purpose for, and the procedures, equip-ment, and safety precautions used with, each of the following control techniques:

(a) Absorption
(b) Dike, dam, diversion, retention
(c) Dilution
(d) Remote valve shutoff
(e) Vapor dispersion
(f) Vapor suppression

Introduction

To this point, you have learned about how the hazardous materials can harm you. You have learned how to identify the hazards presented by a hazardous material and about how to protect yourself from those hazards. You are well on your way to becoming a hazardous materials responder at the operations level.

Now, you about to learn about the defensive action options available to you at the operations level. Your primary responsibilities are to protect people, the environment, and property. There are several methods at your disposal to control a hazardous materials incident. Establishing control zones, evacuation and sheltering, and controlling the product all give you control of the incident.

In many cases, you can do little. Take for example the boxcar fire in Danville (Boyle County). The boxcar was loaded with several tons of sodium diothionite (UN# 1384). This substance is spontaneously combustible. It has a specific gravity of 1.4 and is soluble in water. When this substance decomposes (burns or mixes with water), it creates sulfur dioxide and hydrogen sulfide gases.

Hydrogen sulfide is a severe health and severe flammability hazard. It has a vapor density of 1.18 and a boiling point of -76° F. It is also soluble in water. Sulfur dioxide is a serious health hazard and has a vapor density of 2.21 and a boiling point of 14° F. Both gases are an inhalation hazard and hydrogen sulfide reacts with water and creates sulfuric acid after an exothermic

reaction. The responders could not stop the breakdown of the sodium diothionite that was producing the toxic gases. The only option was to establish perimeters and evacuate people

This boxcar created a lot of problems in Danville. The only action that could be taken was to establish perimeters and wait.

while encouraging others to shelter themselves in their homes.

At the operations level, there is very little that can be done in this case, other than maintain a perimeter and establish hot, warm and cold zones. You cannot stop the release of the gas, nor can you stop the decomposition process. Those action options belong to technicians and specialists.

This incident took several days of standing by and watching the material decompose before specialists and chemists were able to start neutralizing the chemical. You have to be able to recognize situations like these when you must not intervene. You have heard this all through this course. However, it is so important that you understand that doing nothing may be the best option.

However, there are other times, such as when a pipeline ruptured in Clark County, near Winchester. The actions of the first responders saved the environment and several thousands of dollars in property. An eighteen-inch pipeline failed while crude oil was being pumped to the Cattletsburg refinery at a great pressure. Several hundred thousand of gallons of oil were released onto the ground. The diking and damming operations that the local first responders did prevented further disaster and damage.

By the end of this chapter, you will know the techniques to accomplish many protective actions. You will learn the purpose of controlling releases, as well as the different methods that are used throughout the hazardous materials emergency response industry.

Your job, as a hazardous materials first responder is to minimize or prevent harm to life, the environment or property. You know that spills must be handled property because of the potential of the damage a release of a hazardous material has.

Any improper actions, whether they are done under the best intentions are still damaging. A hazardous material is not discriminating. The hazards of the material will damage the health of the good and the bad.

You know that spills can occur at any time in the life of a chemical. Whether it is during the manufacture, transport, storage, use or disposal, a chemical still has the ability to create damage

to the health, the environment, and property.

Each spill or release is unique. Every incident has a unique set of circumstances. Above, you read about the Danville boxcar incident when sodium diothionite (UN# 1384) caught began to decompose, catching fire. A few months later, a boxcar loaded with the same chemical caught fire in Wisconsin and caused a different set of problems for the responders. The point is that you must always remember that there will never be a routine hazardous materials run.

Establishing Control Zones

You may be wondering why it has taken this long to discuss this topic. The answer is that you have to take into account all of the hazards and things discussed to this point before you can get a firm grasp on the complexities of an incident.

As mentioned earlier in this course, control zones are methods of providing for worker safety, control of the work activities on an incident scene, and the prevention of contamination spread. Work zones are set up as required. They will identify where various types of work will occur.

In addition, they will ensure that personnel are properly protected against the hazards present in the areas they are working. They will make certain that work activities and contamination are confined to appropriate areas. They make the location of personnel easy in an emergency. Finally, they will control the accessibility to work zones.

Usually, one to three work zones are established. The Hot Zone is the exclusion zone, usually designated as red. The Warm Zone is the contamination reduction zone and is designated yellow. The Cold Zone is where support personnel are and is usually designated green.

As mentioned, these zones need to be clearly communicated and marked. These zones also provide site security, keeping unnecessary and/or unprotected people out. These zones will prevent vandalism, theft and sabotage and prevent evidence from being disturbed.

Criteria for Control Zones

Control zones use distance to protect people. There are several ways to determine the size for these zones. One method is to classify the incident as minor, major, or an explosion hazard. An example of a minor incident would be a 55-gallon drum leaking. An example of a major incident would be a leaking tank truck. An example of explosion potential is a tank truck or railcar with direct flame impingement.

A minor incident would require a hot zone perimeter of 100 feet or the isolation distance in the reference material from the leaking drum. You should use which ever is greater. A major incident would require a hot zone perimeter of 500 feet or the isolation distance recommended in the reference material from the leaking tank car. Use which ever is greater. An explosion hazard should be ½ mile or the distance in a reference. Again, use the greatest distance.

Establishing the outer perimeters (Cold Zone) is as important to the operation as establishing the Hot Zone. Use 1000 feet from the edge of the Hot Zone as a minimum. When you establish this zone, you should take into account how much space you will need for the support personnel that are present, and those that may arrive. In addition, you should identify any hazard, including downwind hazards, that may create the need for a greater zone distance. It is easier to make your area oversized than to expand it later.

An important part of establishing your zones is gaining control of access routes. You can do this by closing the roads to all but emergency traffic. However, if you do this, you should have a

routing plan for traffic diversion. The University of Kentucky's Transportation Center and the Kentucky Transportation Cabinet has developed an extensive list of route detours for just these occasions. You may choose to have law enforcement or traffic safety personnel divert traffic. However, you may also use key intersections as staging areas, until barricades or personnel can be placed.

This leads to another discussion on authority. You need to know where your authority begins and ends. This is where teamwork between the local emergency response agencies is important. Agencies or individuals in the emergency response communities have different levels of authority in a jurisdiction. It is important for all emergency response agencies to work together to accomplish the same objectives.

Protecting People

When it comes to protecting people threatened by a hazardous materials incident, you have two options, evacuation or shelter in place. As always, you must make certain you are in a safe place. However, you should use your loudspeaker, a public address system, or even the area's Emergency Alert System (EAS) to keep unnecessary people away from the scene. For example, in Richmond, the community's warning system has a voice capability that is used primarily in case of a release of the chemical weapons on Bluegrass Army Depot or severe weather. However, many other communities have radio or cable television system overrides that will allow the broadcasting of emergency instructions to households.

In case of a fast-moving non-flammable gas cloud that is expected to dissipate, sheltering-in-place is a viable option. This is accomplsihed by having citizens move indoors, close all windows and doors, and shutting down ventilation systems. Public education is essential to success. This means enlisting the help of the local media to provide instructions before the emergency.

Goals of Spill Control

The goal of spill control is to prevent harm to the environment. In some cases, you will not be able to totally prevent harm to the environment. Take the Clark County pipeline break. The pressure in the pipeline was so great that the oil was spouting up in several small geysers several hundred feet from the site of the break. The environment was damaged. There is nothing that these responders could have done to prevent the damage to the environment, the challenges were too great.

Your prioroties in hazardous materials response are clear: life and health, environment, and property. If you have the knowledge, some ingenuity, and a few very common, inexpensive tools, you can do a lot to prevent or minimize the damage to the environment.

There are two objective of spill control: containment and confinment. Containment is preventing a hazardous material from escaping a damaged container. Confinement is to control where a hazardous material that has been spilled or released from its original container is going.

Offensive, Defensive – What's the difference????

Control methods can be categorized according to their objectives. They may be either offensive or defensive methods. As a first responder at the operations level, you are trained to respond in a defensive fashion. Technicians and specialists are those who respond in an offensive fashion.

For example, you are called to an accident in Elizabethtown. A DOT-406 has been hit by a passenger vehicle. The tank trailer is intact and upright, however, the 60-gallon saddle tank on

the tractor is leaking at about ½ gallon per minute. You are trained to the operations level; therefore, you would build a dam to prevent the uncontrolled spread of the fuel – defensive action. Take the same scenario, but you are trained to the technician level. You might attempt to stop the leak by

plugging or patching the tank – offensive action.

A second scenario is a DOT-407 leaking at the discharge pipe. At the operations level, you will use the emergency cutoff located near the left from of the trailer. This is containment, but a defensive option. At the technician or specialist level, you may replace the valve. This is containment, but an offensive option.

You must remember that you cannot exceed your scope of practice. Just as you would not want to have an EMT performing an appendectomy, a responder at the operations level cannot plug and patch. Operations level hazardous materials first responders can confine the release from a safe distance, keep it from spreading and prevent exposures. In most cases, containment will be left up to the technician and specialist levels of hazardous materials first responders.

Confinement is the operations level main option. The confinement methods depend primarily on the state the substance is when it is released from its container.

Containerizing

Solids

Dust, powders, granules, or chunks are usually the easiest to deal with because of gravity. However, wind and rain can reek havoc on your efforts. Here are methods for dealing with spills of solid materials.

1. Containerizing is the technique of confining the spill by placing the chemical and or its container in a larger, intact container. If you were loading your truck with granulated ammonium nitrate at the feed store, and a bag fell off the dock and broke open, what would you do? Activating the emergency operations plan may be a bit premature. You would simply scoop up the mess, put it in another bag and

go on. The only caution is that you must make certain that the equipment you use is compatible with the substance you are using.

2. Covering is another method of confining solids. This entails covering them with a tarp, plastic sheeting, soil, etc. This is also an acceptable method of preventing rain from falling on a spilled water-reactive substance. Be certain that the material you use is compatible with the substance.

Do not use water as a cover. This may facilitate the substance leaking onto the ground. Also, be aware that substances can change forms as the environment changes. If the temperature rises or falls, the humidity increases, etc can have a profound effect on the substance.

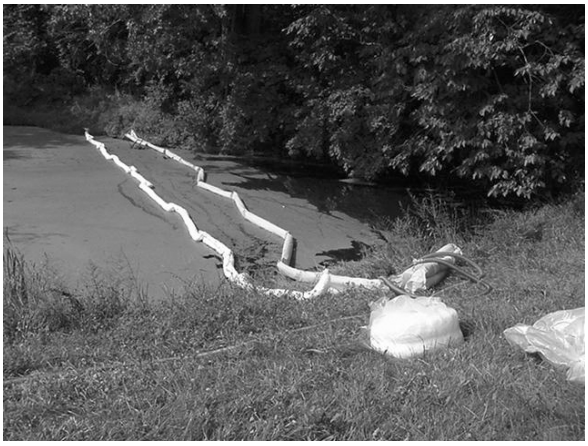
Liquids

Retaining

Liquids will conform to their containers and follow the path of least resistance. You must keep the spilled liquid out of the waterway. Once it enters a waterway, controlling the material becomes a much more difficult task.

1. Retaining a liquid is an effective means of control. This is simply using another container to catch the liquid for later disposal.

2. Diking is a way to control the direction of the flow of a liquid to a desirable location for holding the chemical. Dikes can be built of soil, clay, soil filled plastic, even a charged firehose. Even pre-manufactured special absorbent booms can be used as dikes.



Diking with booms

Do not dig holes or trenches. This will increase the rate of soil permeation. Protect storm drains by covering them and lining the edges with dirt or heavy objects.

3. Absorption is a technique that utilizes any solid capable of drawing in or absorbing a liquid several times its own weight and mass. When used in moderation, this technique is effective. Make certain that your sorbent is compatible with the substance. You must also understand that the sorbent is contaminated and will have to be transported/disposed of with the chemicals.

There are several options that may be used for absorbing a liquid substance. Pads, booms, socks, booms and other products are available commercially. However, you can use materials such as:

- Sand or soil – Dirt is a much better absorbent than sand. It may be possible to draft a mutual aid agreement with your local public works to deliver dirt.

This was a diesel spill in Floyd County. The absorbing material was put down by the first responders. The trucks in the background are clean-up contractors.

- Diatomaceous earth – This is available from local suppliers and may be preplanned for delivery.
- Sawdust – Sawdust is lightweight and easy to handle, but can react with some materials. Sawdust will not hold on to the absorbed material for an extended period of time.
- Absorbent clay – If you want to use absorbent clay, then you should identify a supplier and have them keep the materials in stock and available 24-hours a day.
- Vermiculite – this is an extremely effective and readily available substance. Walmart, Lowes and other stores that have garden supplies have vermiculite available in small quantities.
- Imbibbing materials – These things hold on to the material until a chemical process occurs reversing the molecular adhesion.

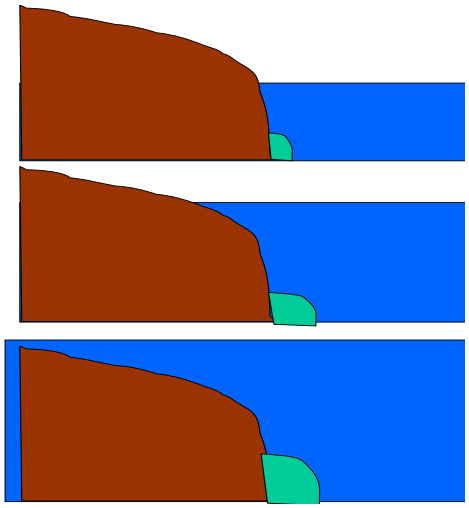
4. Dams are barriers built to hold back flowing liquids. The key word is flowing for this type of application. Dams may be used for fire stream runoff or free flowing product. However, there is a limit to the practicality of using a dam. Rivers or fast flowing streams are probably beyond any response agency's capabilities.

   Take for example the May 2000 distillery fire near Lawrenceburg in Anderson County. 250,000 gallons of aging whiskey was rapidly released when a warehouse burned. The speed and quantity of the release was simply too much for anyone to control.

   There are two types of dams, simple and complex.

- Simple dam is a wall that keeps chemically contaminated water in one place. Simple dams can be constructed from most of the materials used to make dikes. Shoveling dirt into a natural eddy or drainage ditch to allow pooling and pick-up of the material is an appropriate way to make a dam. **This is a temporary solution.** They require constant monitoring and reinforcement. To prevent seepage into the ground, you may line them with plastic sheeting or by placing soil in garbage bags.
- Complex dams are used when a simple dam is not adequate to deal with the water and with the hazardous materials. There are two types of complex dams: overflow dams and underflow dams.

➢ Overflow dams are used for immiscible substances that sink in water. They get their name



With overflow dams, the water builds behind the dam wall trapping the heavier substance at the base of the wall while water flows over the top.

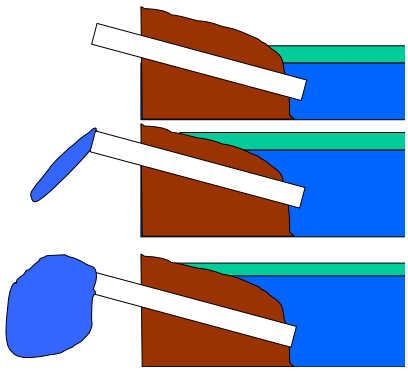
because they allow water to build and overflow the dam wall, while trapping the heavier liquid behind and below.

When using this type of dam, build more than one. Also, you must constantly monitor the level of the trapped chemical to prevent it from also overflowing the dam wall.

These types of dams allow the clean up contractor to to suction the bottom of the waterway to recover the spilled chemicals.

➢ Underflow dams are the opposite of an overflow dam. This is designed for immiscible substances that float on water, such as gasoline or fuel oil. These dams allow water to flow under the dam trapping the substance behind the wall on top.

Underflow dams are built of earth with one or more 6" pipes placed in the lower part of the wall running parallel to the stream. The end on the downstream side of the dam must be higher than the end on the upstream side. You must keep the upstream end sealed until the water rises well above the downstream end. As the water rises to the tip of the downstream side, the pressure will force the water out of the pipe.



Underflow dams are used when the substance is lighter than water.

You must monitor this type of dam too. They also make clean up easy because the chemical can be skimmed off the surface or absorbed by using pads.

Prior to constructing a dam, you should build a confinement area using simple dams and dikes to buy time while the complex dams are being constructed. Also, separation dams need to be far enough away from the confinement area so you have sufficient lead time before spillover occurs. Plywood are helpful in constructing dams. In some cases, it may be necessary to build two or more confinement areas to give you lead time.

5. Remote shutoff valves can be operated from a distance, usually by electronic means. These provide a way to contain or slow the flow of hazardous material from a delivery or recirculating system. The emergency shutoff valve on an MC-331 is an example of this.

   These remote shutoffs are good because they can have a very fast response time or are tied into a monitoring system. This reduces the amount released into the environment. Trained plant personnel, railroad workers, and drivers can operate these valves without waiting on the extended response times of emergency response personnel, provided they are located in a safe location.

   However, these valves and untrained personnel will react to false alarms casuing unnecessary shut-downs. In addition, these valves can fail requiring a manual back up.

6. Covering the liquid may also be a viable option. This will prevent vaporization. You must make certain that the material you use to cover the hazardous material is compatible with the

spilled materials before you cover it. You may also decide to use a vapor suppressing foam. Use extreme caution with this technique so that you do not spread the material. In addition, you must make certain that your foam agent is compatible with the material. In the early 1990's, a train derailed in Rubbertown just outside of Louisville. Several tank cars of hydrogen fluoride acid were ruptured spilling the HF on the ground. The proper procedure is to use a water fog to keep the vapors down. However, directly behind the HF cars were several broken containers of calcium carbide, which, when mixed with water creates acetylene gas. You have to be certain of all the hazards before you choose an option.

7. Dilution is also a possible control technique. This will reduce the degree of danger presented by the chemical hazard. For acids and alkalis, dilution will reduce the corrosiveness, which can be checked by pH paper. It is best to use this only on small spills.

   Dilution is not a simple and easy process and can be tricky and dangerous. You must make certain that the proper method of water and corrosive mixing must be understood. If this is done improperly, a reaction may happen, resulting in the injury of workers and further spread of contamination.

   Therefore, dilution is rarely practical and should not be a first option for hazardous materials control

Gases and Vapors

Gases are the most difficult to control. They tend to engulf an area in all directions at once. Depending on the buoyancy – the ability to rise or fall – of a gas, is determined by several factors, the most important of which is the vapor density.

Simply closing doors and windows can confine gases that are escaping in an enclosed area such as a room or a building. Gases should be allowed to escape unless they present a hazard or increase contamination. Be aware that gases that are heavier then air will settle on the lower floors and those that are lighter than air will rise to the upper floors of a building.

When gases are escaping outdoors, they are more difficult to control. You must consider whether the gas will rise or fall; this is of extreme importance with gases that are colorless and odorless. Gases will dissipate in the atmosphere over time. This process can be facilitated by using portable fans or a water fog spray. Again, you must make certain that the substance is not water-reactive.

Fire Control

In some incidents, you will encounter a fire in conjunction with a hazardous materials incident. You must know what tactics the fire department is doing. First, do not extinguish a leaking gas fire unless the leak can be stopped. As long as a fire is burning, it is controlling the material and lessening the potential explosion hazard, although the potential for BLEVE is increased. Also, letting the substance burn will often reduce poisons to relatively inert materials. Be aware that these can burn in excess of 2000° F.

If the fire involves tanks, the firefighting efforts should take place from a maximum distance or using unmanned hose holders or monitors. Should a BLEVE take place, personnel who are close enough to apply water would be killed.

You should also cool water with flooding quantities of water. This will help prevent container failure, although you already know that there are many variables that may cause a tank to fail.

The minimum flow rate is no less than 500 gallons per minute (gpm) per point of flame impingement. Your goal is to apply a sufficient amount of water to the vapor space of the container so that the water is able to cascade completely down the sides without evaporating. Before you decide to do this tactic, you must make certain you have an adequate water supply and know how long the flame impingement has been occurring, and have enough resources to act quickly. If not, you should pull back and evacuate.

Dry chemical, carbon dioxide, foam, or water sprays are possible for use on a small fire, if the material is compatible. Use these agents with extreme caution. Water and foam are better to use on larger fires. However, these things are capable of spreading the materials.

Another action you can take is to move the container from the fire area if you can do so without risk. This is removing the fuel from the fire. However, it takes a large amount of personnel to move these drums. Always keep life safety as the prime consideration.

Only specialists should handle damaged cylinders. This is considered an offensive action. If a container is leaking, do not direct water at the source of the leak or at safety devices. This may cause icing and could cause the safety valve to not work properly. If water enters the tank, it will displace the substance in the tank.

Section Five

Doing the Best Option

Chapter Thirteen – Implementing the Plan

Terminal learning Objective

After developing a response plan, the first responder at the operational level shall determine the steps necessary to implement the plan

Enabling Learning Objectives

Describe the role of a safety-oriented attitude required to implement a response plan.

Describe the content of a pre-action brief.

Communicate your plan to the response crew.

Introduction to Implementing the Plan

You have come to the point of being ready to put the plan you have developed into action. You will need to take your objectives and the options you have developed from them, and execute them. In order to do this, there are a few things you must do. You have to ensure that you have all of the necessary equipment and personnel. You have to communicate the plan to the response crew so they understand what they are doing. However, the most important thing you can do for a safe, effective, and efficient response is to make certain that all of the possible safety precautions have been taken.

This chapter will help you do this. At the end of the next chapter, you will be shown several pictures of incidents or potential incidents. You will again use the Incident Log from the Kentucky State Emergency Operations Plan. One of the unofficial goals of this course is to show you the importance and need of writing things down. Whether it is the site safety plan or the chronological unfolding of the events, or even a diagram of the incident scene, it is very important to commit it to paper. Increasingly, hazardous materials incidents are court bound. As a responder, you may find yourself on the witness stand, defending the actions you took on a scene. The written documents provide a great deal of help to your memory on why you may have done a particular action.

The role of a Safety Attitude

The attitude of you and your team are essential to the goal of having a safe, effective and efficient response. People's attitudes come and go on safety. This is just human behavior. If people do not feel that there is an imminent danger, then safety attitudes lessen. However, safety is always needed and always at high levels. If you or your team views safety as a bothersome task, accidents are more likely to happen. Therefore, it is imperative to have a positive attitude about safety as you prepare your team for action.

General Response Considerations

When you are sending your team into action make certain that they eliminate all ignition sources from their person. Also, make certain that all ignition sources are kept out of the Hot Zone. Road flares should not be used in ½ mile of a spill or release.

Make certain that the tools being used are grounded. This will prevent sparking, and ultimately an ignition source. These are important guidelines to follow to prevent a fire. Remember that chemical protective equipment provides little thermal protection.

Briefing the Team

One of the most important things you must do before implementing the response plan is to brief your response team. As an operations level hazardous materials responder, you may find yourself as the Operations section Chief or the Incident Manager. You have to be able to clearly communicate the objectives of your response and the action plan to the team.

When you address the team, assign a safety officer. In the chapter on the Incident Management System, you learned about the roles and responsibilities of the safety officer. You should also assign a decontamination officer. Review the chapter on decontamination for the roles and responsibilities for the decon officer.

Assign the defensive entry personnel. These people will perform the defensive actions you have determined that need to be accomplished. Choose these people wisely. Make certain they have the appropriate level of training and ability to do the job.

Assign the back-up team. Make certain they have the necessary training and abilities to perform that task. Assign a medical officer if you need one. If you have people in an encapsulation suit, then you should have a medical officer.

Once you have done these things discuss the following points with the team.

- The nature of the emergency.
- What will happen if nothing is done.
- What actions others have taken.
- How and where the hot, warm, and cold zones.
- Who is maintaining the perimeter.
- Any available information on the product(s) involved.
- Limitations of PPE
- What are you doing? Reconnaissance, rescue, evacuation, confinement, control, or wait for additional resources.

Briefing the team is important before beginning incident operations.

- Ask for their input on the incident mitigation plan.
- Have all of the hazards (environmental, chemical, and physical) been evaluated and re-evaluated.
- Does everyone understand the defensive objectives, strategies, and tactics?
- On-scene communications plan.

Once this briefing has occurred, your team is ready to get the safety briefing from the safety officer. This briefing should cover the risks and hazards of the incident. The complete briefing of signals that may indicate the alteration or suspension of operations must be addressed. In

addition, any circumstances that would indicate the escalation of the incident are also to be addressed.

Once everyone has completed this briefing, your team is ready to deploy and start operations. Decon is the first thing to be set up. It is advisable to set up decon in the Cold zone near the edge of the warm zone. This way, the people setting up the decontamination corridor do not need to be in PPE. Once the decon line has been established, you can simply move the warm zone line back to include the decontamination corridor.

Medical monitoring can start at the same time as the decon setup and yet others can begin to pull equipment and stage it for easy access. There are infinite ways to proceed from there. You have to practice and determine the best way for your team to operate. Again, this class is the beginning of your process.

SECTION SIX - EVALUATING PROGRESS

Chapter Fourteen – Evaluating the Progress

Terminal learning Objective

Given simulated facility and/or transportation hazardous materials inci-dents, the first responder at the operational level shall evaluate the status of the defensive actions taken in accomplishing the response objectives.

Enabling learning objectives

Identify the considerations for evaluating whether defensive options are effective in accomplishing the objectives.

Describe the circumstances under which it would be prudent to withdraw from a hazardous materials incident.

Identify the methods for communicating the status of the planned response to the incident commander through the normal chain of command.

Plan a response within the capabilities of available personnel, personal protective equipment, and control equipment by completing the following tasks:

Identify the response objectives for hazardous materials incidents

Identify the potential action options available by response objective

Select the personal protective equipment required for a given action option

Select the appropriate decontamination procedures

Develop a plan of action, including safety considerations, consistent with the local emergency response plan and the organization's standard operating procedures, and within

Introduction

You have nearly made it. The response plan in underway and in action. Now, you have to determine, "Is it working the way we planned?" You have to constantly evaluate the progress, or in some cases, the lack of progress of the efforts your efforts are making.

Is it working

As the operations section chief or the incident manager, you need to evaluate the progress and determine if you "stay the course" or "pull back and regroup." This is a judgement call in many cases. The best criterion to go by is to determine if you are meeting the response objectives. If you are, then stay the course, if all things are remaining the same. However, if your team is not controlling the material or are in danger, you must pull back and regroup.

"Pulling back" may mean a change in tactics or a complete retreat. Again, each situation is different and no definitive criterion can be offered in this course other than the safety of your team and the effectiveness of your efforts.

When to Pull Back

By this point, you understand that safety is the primary concern of all the actions to be done. The short answer is you must pull back anytime your team is in danger. Therefore, you must withdraw immediately if you hear a rising sound from venting safety devices. As the internal pressure builds in a container, the relief valve will whistle loudly while it vents, usually a steady pitch and

volume. If a rising sound occurs, it means that the pressure is building. When the rising sound reaches a sustained pitch, the container reaches its maximum design limits. Therefore, if pressure continues to increase, the container will fail.

If you see the discoloration of a tank due to fire, you should assume that the tank is failing and you should evacuate the immediate area.

Finally, stay clear from the ends of the tanks. You have learned that the welds are the near the weakest points of the tank. Their failure can be catastrophic to bystanders and responders. However, there are also tanks manufactured in a wrapped style and they can come unwound like a spring and kill bystanders. You must study the containers you are dealing with to provide for your safety.

Communicating Progress

You have already learned that before you send a team in you must establish communications, both verbal and non-verbal. You have learned that you will be giving briefs or receiving briefs communicating the objectives and tactics. If you are the Operations section Chief then you will be giving a brief to the Incident Manager showing progress. If you are further down the chain of command, then you will report to your supervisor any progress. Then your supervisor will report it to his or her supervisor. This is how communications are accomplished on scene.

Conducting briefings is an important part of controlling an incident. These may be to the media, team-members, or other officials.

Exercises

In the next few slides you will be presented with situations that you will have to do the following:

- Detect the presence of hazardous materials
- Estimate the likely harm without intervention
- Choosing the response objectives
- Identifying the action options
- Doing the best options
- Evaluating your progress

In the back of your book is a set of three KyEOP Incident Logs. You will use those throughout the

exercise. In addition, you will be split into small groups to accomplish the tasks before you. Use all of the resources available to you in this class. Your instructor will give you further information.

Appendix A
KyEM Incident Logs

KENTUCKY EM INCIDENT LOG						Page 1
GENERAL INFORMATION						
INCIDENT#:			TIME REPORTED:			
DATE:			TIME OCCURRED:			
COUNTY:			COMMUNITY:			
INCIDENT LOCATION:						
TIME NOTIFIED:						
REPORTED BY:		AGENCY :		PHONE:		
SITUATION REPORT						
# INJURIES:		# DEATHS:		# EVACUATIONS :		
# SHELTER:		LOCATIONS:				
STREAMS AFFECTED:						
PROPERTY DAMAGE:						
ROADWAYS CLOSED/DETOURS (MM):			EXPECTED OPEN:			
EXPECTED ALL- CLEAR TIME:						
WEATHER						
TEMP		DEW POINT		WIND SPEED/DIRECTION		PRECIPITATION (RAIN, SNOW, ETC)
TYPE OF INCIDENT						
HAZMAT		NATURAL HAZARD		TRANSPORTATION		OTHER EVENT		SEARCH/RESCUE	
SPILL		THUNDERSTORM		RAILROAD		TERRORISM		LOST PERSON	
AIR RELEASE		TORNADO		HIGHWAY		MEDICAL		DROWNING	
FIRE		FLOOD		AVIATION		CIVIL DISORDER		USAR	
EXPLOSION		WINTER STORM		PIPELINE		EVACUATION/SHELTER		MISSING AIRCRAFT	
CSEPP		EARTHQUAKE		MARINE		UTILITY/WATER		HIGH ANGLE	
RADIOLOGICAL		OTHER		OTHER		OTHER		CAVE	
INITIAL INCIDENT INFORMATION						
(USE INCIDENT JOURNAL, PAGE 10, FOR CONTINUATION)						
STATE STAFF ROLE:			INCIDENT COMMANDER (WHO)			
INCIDENT ACTION PLAN:	YES		NO		DATE/TIME	
SITE SAFETY PLAN	YES		NO		DATE/TIME	

HAZARD INFORMATION

CHEMICAL NAME	AMOUNT RELEASED/ SPILLED	UN #	GUIDE #	CAS # PLACARD	TOTAL AMOUNT	CHARACTERISTICS		
						FP	LEL	UEL

EHS	YES		N0		RQ (AMT)		CERCLA	YES		NO		RQ (AMT)	

STATE

SOLID		LIQUID		GAS		LIQUID COMPRESSED GAS		PURE		MIX		WASTE		OTHER	

HAZARDS

CORROSIVE		ACTIVE TOXICITY		DELAYED		TOXICITY		FIRE		REACTIVE		SUDDEN RELEASE		RADIO ACTIVE	

RESPONSIBLE PARTY INFORMATION

COMPANY			
CONTACT PERSON			
ADDRESS			
CITY, STATE, ZIP			
PHONE			
E-MAIL			
FAX			

CLEAN-UP CONTRACTOR

CLEAN-UP CONTRACTOR			
CONTACT PERSON			
ADDRESS			
CITY, STATE, ZIP			
PHONE			
FAX			
ETA			

INCIDENT ACTION AND SAFETY PLANS

ACTION PLAN	YES		NO		DATE/TIME	
SITE SAFETY PLAN	YES		NO		DATE/TIME	

INCIDENT ACTION PLAN

INCIDENT PRIORITIES

1ST	LIFE SAFETY	
2ND	INCIDENT STABILIZATION & PROTECTION OF THE ENVIRONMENT	
3RD	PROPERTY CONSERVATION	

WHAT IS THE PROBLEM?

STRATEGIC GOALS

TACTICAL OBJECTIVES

TACTICAL OBJECTIVES	RESOURCE ASSIGNMENT PER OBJECTIVE

PLAN SUMMARY

MITIGATION MEASURES

IMS/UNIFIED COMMAND POSITIONS							
ANNEX Q ACTIVATED	YES		NO		TIME:		DATE:	
ACTIVATED BY:							
STAFF FUNCTION	NAME		TIME ON SCENE		TIME RELIEVED		
IC							
SAFETY							
PIO							
LIAISON							
OPERATIONS							
PLANNING							
LOGISTICS							
FINANCE							
DECONTAMINATION							
MEDICAL							
RESOURCE							
STAGING							
SCIENCE							
COMMUNICATIONS							
OTHER							
OTHER							

PROTECTIVE ACTION ZONES [DESCRIBE]

INITIAL ISOLATION ZONE RADIUS		SAFE REFUGE DISTANCE EMERGENCY WORKERS	
EXCLUSION (HOT) :			
CONTAMINATION REDUCTION (WARM):			
SUPPORT ZONE (COLD);			

DECONTAMINATION AND PPE

ZONE	LEVEL PPE	DECON LOCATION SITES
HOT		
WARM		
COLD		

EMERGENCY EVACUATION SIGNAL(S) AND ROUTES FOR WORKERS

SIGNAL	ROUTE

POPULATION PROTECTION ALERTING/WARNING

METHOD OF ALERT	SIGNAL

BEGIN EVACUATION TIME	END EVACUATION TIME	IN-PLACE SHELTER/ BEGIN TIME	IN-PLACE SHELTER/ ALL CLEAR TIME

SENIOR LOCAL AGENCY PERSONNEL ON SCENE			SHIFT 1	2
AGENCY	UNIT #	NAME	TIME ON SCENE	TIME RELIEVED
EM				
FIRE				
POLICE				
SHERIFF				
RESCUE				
EMS				
WATER/SEWER				
ROADS				
COUNTY JUDGE/EXECUTIVE				
MAYOR				
NEWS AGENCY				
OTHER				

SENIOR STATE AGENCY PERSONNEL PRESENT			SHIFT 1	2
AGENCY	UNIT #	NAME	TIME ON SCENE	TIME RELIEVED
EM				
FM				
NREPC/ERT				
MVE				
KSP				
DOT				
NREPC/WATER				
NREPC/AIR				
AG/PESTICIDES				
CHS/EMS				
PSC				
KyNG				

PUBLIC SHELTER/EVACUATION INFORMATION

RECEPTION CENTER		PHONE	
RECEPTION CENTER		PHONE	
SHELTER LOCATION		#SHELTERED	
SHELTER LOCATION		#SHELTERED	
SPECIAL FACILITIES AFFECTED:			

COMMUNICATIONS PLAN

AGENCY	FREQUENCY	PHONE	CELL PHONE	FAX
EMERGENCY PUBLIC INFORMATION ALERTING				

AIRSPACE RESTRICTIONS CALL KYDES DUTY OFFICER 800-255-2587

LATITUDE AND LONGITUDE	N3_._____ W08_._____

RECOVERY

RE-ENTRY & RECOVERY	DATE/TIME BEGIN		END	
FOLLOW UP PROCEDURES/ACTIONS	DATE/TIME BEGIN		END	
SCHEDULE CRITIQUE DATE/TIME				
LOCATION OF CRITIQUE				
REPORT FILED DATE/TIME				

NOTES

INCIDENT SITE DRAWING

NORTH

KENTUCKY EM INCIDENT LOG			Page 10
INCIDENT JOURNAL			Page ___ of ___
DATE	**TIME**	**INITIALS**	**REMARKS**